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Data acquisition

EE463 (1) 18/11/2019

to Transfer information from Tranducer to Controler by changing The electrical signal to Digital.

1- RTD → PT 100 → Transducer for Temp. can read [0 ~ 139 Ω]

@ 0°C = 100 Ω , [0.39 Ω/C°]

Ex: @ 23°C ⇒ 100 + (23 × 0.39) = 108.97 Ω

	TTL		CMOS	
	0	1	0	1
	off	on	off	on
	0 volt	5 volt	0 volt	(3 ~ 18) volt
in →	(0 ~ 0.8) V	(2 ~ 5.5) V		
out →	(0 ~ 0.5) V	(4.9) V		

* الدخل (معين range) لو أكثر ما تشتغل تتحرق !!

* 137 Ω what's The temp. 137 Ω − 100 Ω = 37 Ω

$T = 37\Omega \,/\, 0.39\,\frac{\Omega}{C°} = 94.87\,C°$

مهم → Data acquisition: is The process by which physical phenomena from The real world are Transformed into electrical signals That are measured & Converted into digital format for processing analysis & Storage by a Computer.

2- LM 35 → Tranducer for measure Temp.

(0 ~ 100°C) 10 mV/C° [0 ~ 1 V]

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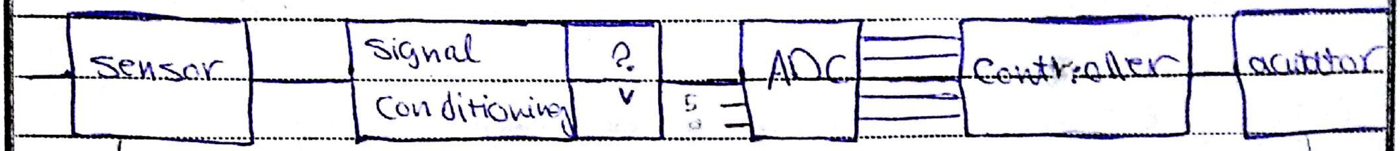
حركة
حرارة
وزن



→ V, A, R, pulse, phase, watt, charge.

إطفاء
حريق
وإنذار

Fundamentals of Data ecquisition

Sensor.
Field wiring.
Signal Conditioning → filtering, Amplification, isolation, linearization, Excitation تهيئة الإشارة
Data ecquisition hardware → عدد المداخل مهم، يعتمد على التطبيق المطلوب
Controller (operating system) → Arduino, pc الخ
Data ecquisition software

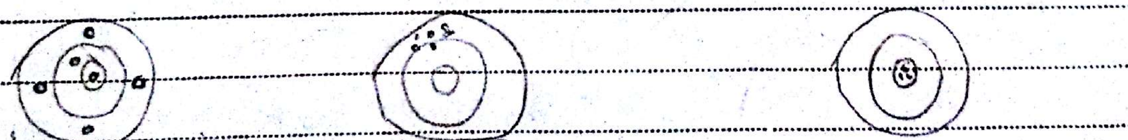
7805 → 5V , 7812 → , 7905 → -5V , 7912 → -
→ Voltage Regulation

Real Time Operating System → يعطي نتيجة في نفس الوقت (فوري)

25/11/2019 EE463 (3)

* Accuracy → تعريف - مدى صحة قراءة الجهاز
وعدم قياس - تقاس بنسبة الخطأ في الجهاز
اسم آخر - Measurment Uncertainty

* precision / Repeatability / Reproducibility →



low precision
low accuracy

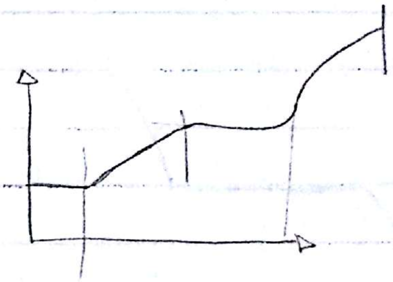
High Precision
low Accuracy

High accuracy
High precision

Brown
black
Red

Resistor (800 Ω ~ 1200 Ω)

★ linearity ▸



- LM35 10 mV/C°
- RTD @0C° 100 Ω 0.39 Ω/C°

▸ EXample ▸

R(Ω)	Temp (C°)
307	200
314	230
321	260
328	290

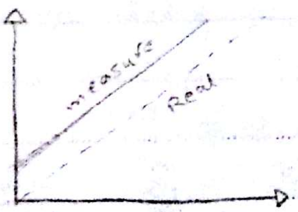
*لكل 30° ← 7Ω

✓ $\boxed{0.23\ \Omega/C^\circ}$?!

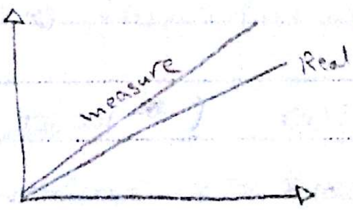
*لو T=0°C ⇐ R=260.3 Ω

$R_{T=0} = 261\ \Omega$

- $\frac{200}{30} = 6.67$ $7 \times 6.67 = 46.67$ $307 - 46.67 = 260.3\ \Omega$



Bias zero drift



Sensitivity drift

→ كل الفرطات الي بين قراءات و آخر واحد هاد accuracy "Read it"
ولو ستة في الاخير Temp coffecient.

Hastreyces

- حتى لما يوصل لمستوى معين توقف المضخة عند المستوى (2) لـ الحد مستويين مختلفين.

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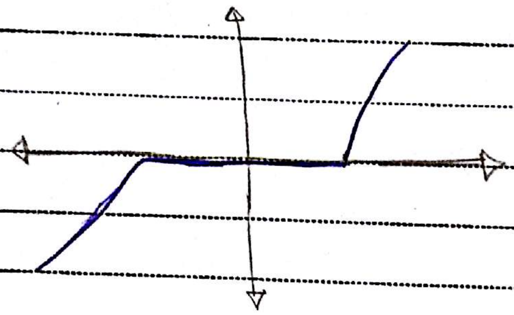


* Reslution ▶

28/ NOV/2019 EE463 (4)

Range ▶ مدى (0 ~ 100)

Span ▶ مدى قياس (~~0~~ 100) = 100 − 0

Range ▶ −20 ~ 120

Span ▶ (120) − (−20) = 140°

Signal Conditioning ▶

RTD ▶ PT100 (100Ω + $100 \times 0.39 \frac{\Omega}{C^\circ}$)

D 0°C = 100Ω , Sensitivity = 0.39 Ω/C°

2 EX ▶ (0 ~ 100°C) Temp range

$(100\Omega + (0^\circ C \times 0.39 \frac{\Omega}{C^\circ}) \sim (100\Omega + (100^\circ C \times 0.39\ \Omega/C^\circ)$

$(100\Omega \sim 139\Omega)$ #

3 EX ▶ (−20°C ~ 120°C)

$(100\Omega + -20^\circ \times 0.39 \frac{\Omega}{C^\circ}) \sim (100\Omega + 120 \times 0.39 \frac{\Omega}{C^\circ})$

$(92.2\Omega \sim 146.8\Omega)$ #

LM35 , sensitivity = 10 mV/c°

Temp range (0 ~ 100°C) , Sensor o/p range (0V ~ 1V)

4EX ▶

accelerometer range (±20g), & @ 0g = 5ma

Sensitivity = 0.115 mA/g, calculate The sensor output range?

note: g وحدة قياس الجاذبية

accelerometer range (−20g ~ 20g)

accelerometer range o/p ▶ (5 + −20 × 0.115) ~ (5 + 20 × 0.115)

(2.7ma ~ 7.3ma) #

5EX ▶

signal conditioning

Sensor → Ω/V → V/V → ADC → Controller

TTL

0/1

0/5

(0 ~ 0.8v) ~ (2 ~ 5.5 v)

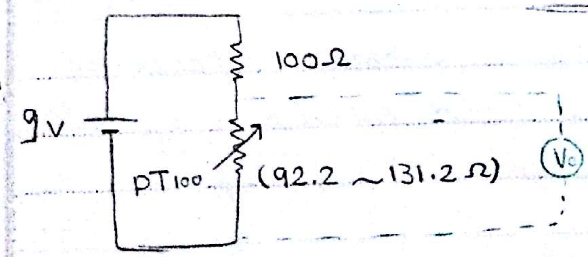
PT100 ▶ range (−20 ~ 80°C)

Sensor o/p range ▶ $[(-20°C \times 0.39 \frac{\Omega}{C°}) + 100] \sim [(80°C \times 0.39 \frac{\Omega}{C°}) + 100]$

(92.2 Ω ~ 131.2 Ω)

← * single Ended

أخذ قياس بين نقطة وأرضي



Voltage devider

@ −20°C

$V_o = 9V \times \frac{92.2}{92.2 + 100} = 4.317V$

@ 80°C

$V_o = 9V \times \frac{131.2}{131.2 + 100} = 5.107 V$

Sensor output range in Voltage (4.317 V ~ 5.107 V)

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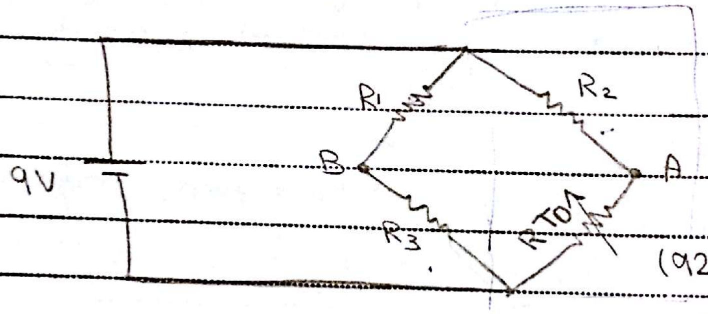
Subject $R_1 = 120\,\Omega$, $R_2 = 130\,\Omega$, R_3 = Calculate using ⊛

"منظرة"



$(92.2\,\Omega \sim 131.2\,\Omega)$

wheston

ميزة الـ bridge عن Voltage devider

1- more accuracy.

2- Start measuring from Zero. "best"

$R_4 * R_1 = R_2 * R_3$ ⊛

$92.2 * 120 = 130 * R_3 \longrightarrow R_3 = 85.107\,\Omega$

صفرى

$$VA = 9 \times \frac{92.2}{92.2 + 130} = V_s \times \frac{R_4}{R_4 + R_2} = 3.734\ V$$

$$VB = V_s \times \frac{R_3}{R_3 + R_1} = 9 \times \frac{85.107}{85.107 + 120} = 3.734\ V$$

$$\Delta V = VA - VB = 0\ V$$

كبرى

$$VB = 3.734\ V$$

$$VA = 9 \times \frac{131.2}{131.2 + 130} = 4.52\ V$$

$$\Delta V = VA - VB = -0.7866\ V$$

Bridge o/P Range $(0 \sim 0.786\ v)$ #

6 EX ▸ , من المثال السابق

(1) Bridge O/P = 0.5 V

(2) Devider O/P = 4.5 V

Calculate The Temp of each ?

from (2) $4.5 = 9V \dfrac{R_2}{R_2 + 100}$, $R_2 = 100\Omega \rightarrow$ Temp $= 0°C$ //

from (1)

$\Delta V = VA - VB$

$\Delta V + VB = VA$

$VA = 0.5 + 3.734 = 4.234\ V$

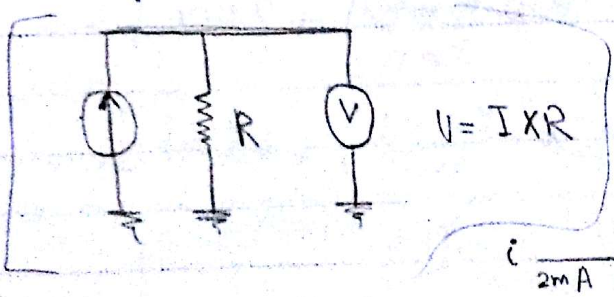
$4.234 = 9 \times \dfrac{RTD}{RTD + 130\Omega} = 115.48\Omega$ //

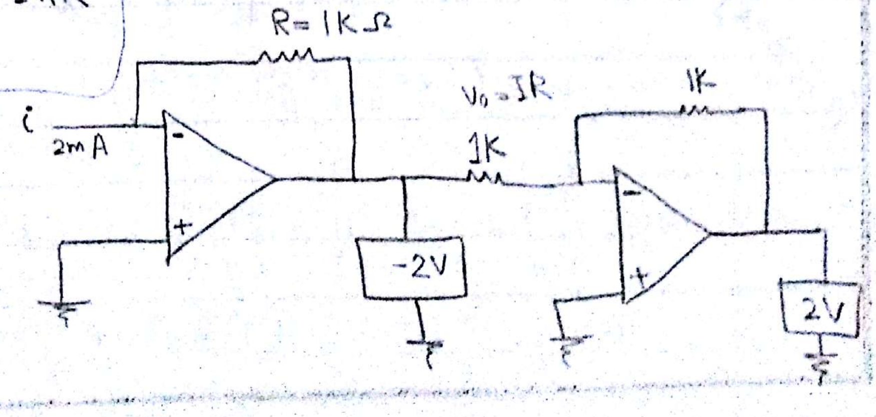
$\dfrac{110\Omega - 100\Omega}{0.39\ \Omega/C°} = 39.69\ C°$ //

(5) EE463 2/12/2019

7 EX ▸

pressure sensor Sensitivity 0.12mA/bar working in The Range (0 ~ 40 bar) , Calculate The Sensor output Range ?





Scanned by CamScanner

$0 \sim 40$ bar

0×0.12 mA $\sim$ 40×0.12 mA

($0 \sim 4.8$ mA)

using Resistance $R = 1k\Omega$

($0 \sim 4.8mA \times 1k\Omega$)

$0 \sim 4.8V$ #

8 EX ▶

pressure sensor sensitivity 0.11 mA/bar & @ Ø bar = 27 mA, working in the Range (1 ~ 15 bar) calculate the sensor output Range and convert it to voltage using $R = 500\Omega$, calculate the voltage Range.

pressure Range (1 ~ 15 bar)

sensor output Range $\left[\left(1bar \times \frac{0.11\ mA}{bar}\right) + 27\ mA\right] \sim \left[\left(15bar \times \frac{0.11\ mA}{bar}\right) + 27\ mA\right]$

[11.69 ex]

(2.81 mA $\sim$ 4.35 mA) X

($27.11 \sim 28.65$) ✓

Voltage Range ($2.81mA \times 500\Omega \sim 4.35mA \times 500\Omega$)

(1.405 V $\sim$ 2.175 V) # X

(13.555 V $\sim$ 14.325 V) ✓

9 Ex ▸

LM35 : Temp sensor working in The Range $(0 \sim 100^\circ C)$ with Sensitivity $10mV/C^\circ$, calculate The output sensor in The Range $(25 \sim 40^\circ C)$

$$\left(25^\circ C \times \frac{10mV}{C^\circ}\right) \sim \left(40^\circ C \times \frac{10mV}{C^\circ}\right)$$

$$(250\ mV \sim 400\ mV)$$

accelerometer	MS1002	MS1005	MS1010	unit
Full Scale acceleration	±2	±5	±10	g
Scale factor Sensitivity	1350	540	270	mV/g

$$V[t] = V[t-1] + \left((A[t] + A[t-1]) * \frac{T}{2}\right)$$

interval

$$Pos[t] = Pos[t-1] + (\underset{V}{\cancel{A}}[t] + \underset{V}{\cancel{A}}[t-1]) * \frac{T}{2}$$

→ ★

10 Ex ▸

Using The accelerometer MS1010, calculate The accelaration, velocity, position, for each following Reading

interval = 100 ms

A[t] velocity

	Time	acc output (mV)	accelatation (g)	accelaration (m/s²)	V[t] m/s	Displacement (m)	Position (m)
t0	0	0	0	0	0	0	0
t1	100 ms	200 mV	200/270 = 0.74 g	0.74×9.81 = 7.26	0.363	0.018 m	0.018 m
t2	200 ms	500 mV	500/270 = 1.85 g	18.167	1.634	0.118 m	0.118 m
t3	300 ms	470 mV	470/270 = 1.74 g	17.07	3.395	0.218 m	0.218 m
t	400 ms	200 mV					
		0 mV	0	0			
		−120 mV	−0.444	−4.36			

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Subject $V[t] = V[t-1] + (A(t) + A(t-1)) * \frac{T}{2})$

from (*) $t = 200$ ms

$V[t] = 0.363 + (18.167 + 7.26)50\times10^{-3} = 1.634$ m/s

$Pos[t] = 0.018 + (1.634 + 0.363)50\times10^{-3} = 0.118$

$t = 300$ ms

$V[t] = 1.634 + (17.07 + 18.167)50\times10^{-3} = 3.395$ m/s

$Pos[t] = 0.118 + (3.395 + 1.634)50\times10^{-3} = 0.36945$?!

$t =$

what's The sensor output Range?

Sensor acc range $(-10g \sim +10g)$

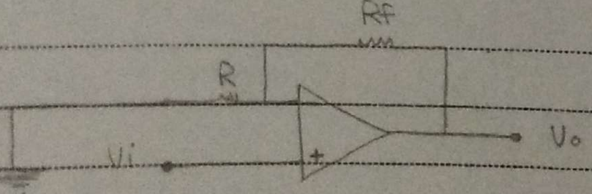
" o/P " $\left[\left(-10g \times \frac{270mv}{g}\right) \sim \left(10g \times \frac{270mv}{g}\right)\right]$

$(-2.7v \sim 2.7v)$

4/12/2019 EE463 (6)

operational Amplifier: op-Amp

non-inverting Amp:



$V_o = \left(\frac{R_f}{R} + 1\right) V_i$

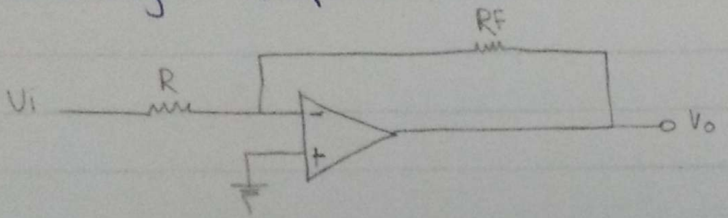
EX ▶

$R = 1K\Omega$, $R_f = 1.5K\Omega$, $V_i = 1.75V$, $V_o = 4.375$ #

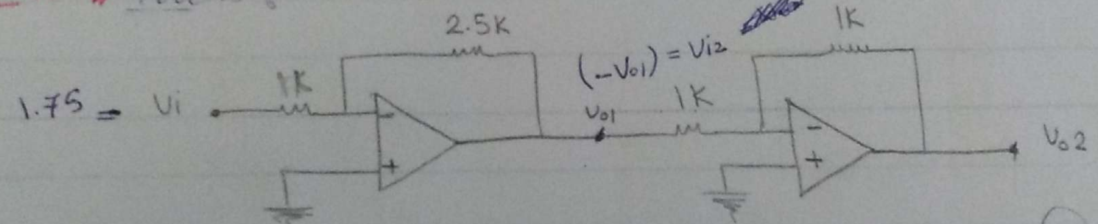
Same fig above ☺.

② inverting Amp ▶

$\boxed{V_o = \frac{-R_f}{R} \times V_i}$?!

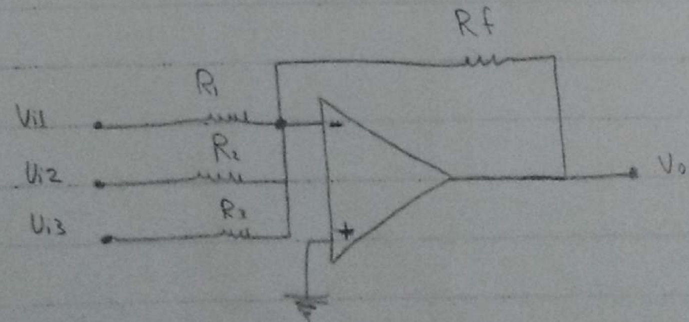


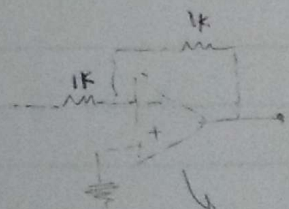
12 EX ▶



$V_{o1} = -4.375$, $V_{o2} = 4.375$ # ✓

③ Addition ▶





بش يقلب الإشارة

$$V_o = \left(\frac{R_F}{R_1} V_{i1} + \frac{R_f}{R_2} V_{i2} + \cdots + \frac{R_f}{R_n} V_{in} \right)$$

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13 Ex ▶ $R_f = 2.5\,K\Omega$, $R_1 = R_2 = R_3 = 1\,K\Omega$
$V_1 = 1.25\,v$, $V_2 = 0.75\,v$, $V_3 = 2\,v$, $V_o = ?$

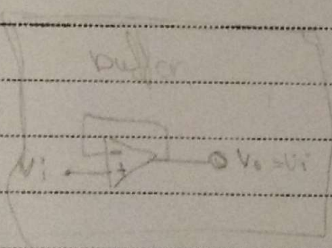
$$V_o = 2.5\,(1.25 + 0.75 + 2) = 10\,V$$

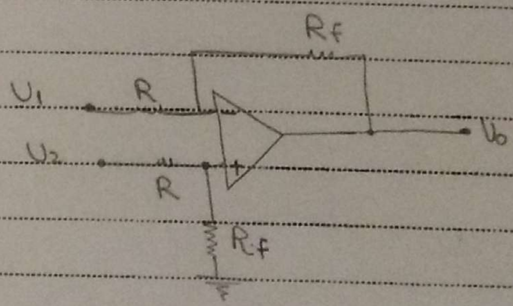
14 Ex ▶ find $2V_1 + 3V_2 + \frac{1}{4}V_3 = ?$

15 Ex ▶ what's The average of The inputs ?

$$\frac{1.25 + 0.75 + 2}{3} = - \quad \#$$

(4) Subtructor ▶



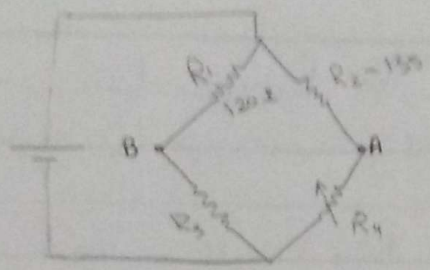


$$V_o = \frac{R_f}{R}(V_1 - V_2)$$

$$V_o = \frac{R_f}{R}(V_2 - V_1)$$

16 Ex ▶

RTD PT100 in The Range $(20^\circ c \sim 90^\circ c)$, using whenstone bridge , design circuit to which $R_1 = 120$, $R_2 = 135$, $V_s = 12\,V$, calculate the o/p voltage range from The bridge.



Temp Range -(20°C ~ 90°C)

Resistance Range $[100+(20\times0.39)] \sim [100+(90\times0.39)]$

$(107.8\ \Omega \sim 135.1\ \Omega)$ //

$R_4 R_1 = R_3 R_2$

$R_3 = \frac{R_4 R_1}{R_2} = \frac{107.8 \times 120}{135} = 95.82\ \Omega$ //

$V_A = V_s \frac{R_4}{R_4+R_2} = 5.3278\ V$ //

$\Delta V = \underline{V_A - V_B} = \underline{0}$ ✓

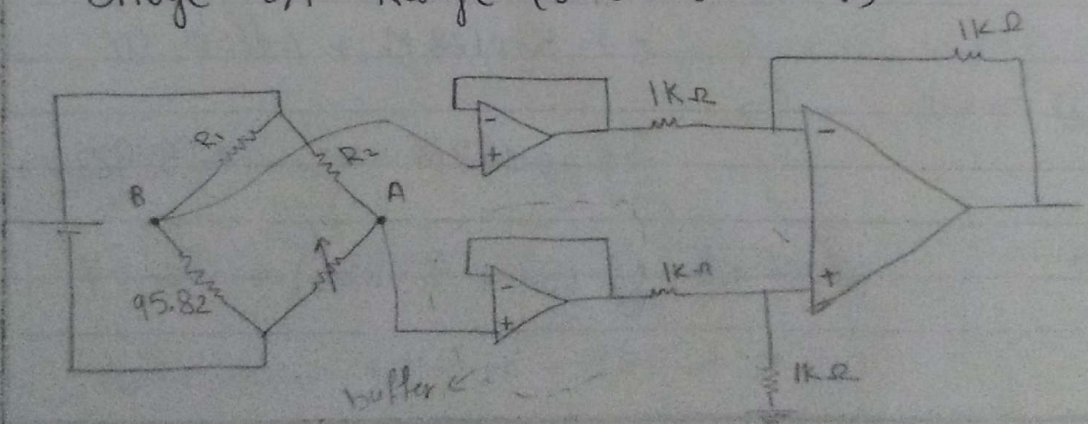
$V_B = V_s \frac{R_3}{R_3+R_1} = 5.3278\ V$ //

@ 90°C

$V_A = 12 \frac{135.1}{135.1+135} = 6.0622\ V$

$\Delta V = V_A - V_B = \underline{0.67442}\ V$

bridge O/P Range $(0 \sim 0.67442\ V)$



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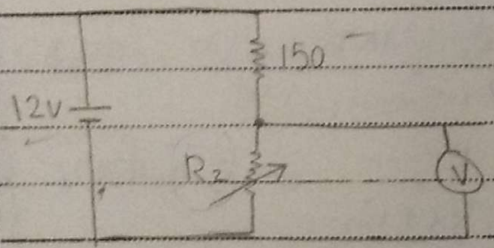
EX ▶ using RTD PT100 in The Range ($20^\circ C \sim 90^\circ C$) design circuit to set o/p Voltage range ($0 \sim 4V$)?

using Voltage devider with $R_1 = 150\,\Omega$, $V_s = 12V$

RTD range ($107.81\,\Omega \sim 135.1\,\Omega$)



@ $20^\circ C$

$$V_o = 12 \times \frac{107.81}{107.81 + 150} = 5.018\ V$$

@ $90^\circ C$

$$V_o = 12 \times \frac{135.1}{135.1 + 150} = 5.686V$$

o/p range ($5.018V \sim 5.686V$)

$V_o = V_i M + \text{offset}$

$4 = 5.686\,M + \text{offset}$ ①

$0 = 5.0178\,M + \text{offset}$ ②

subtract ② from ① ⟶

$4 = 0.668\,M \Rightarrow M = 5.98862$

offset $= 4 - (5.686 * 5.98862) = -30.04$

$V_o = V_i \cdot 5.982 - 30.04$

1. voltage Divider
2. bridge

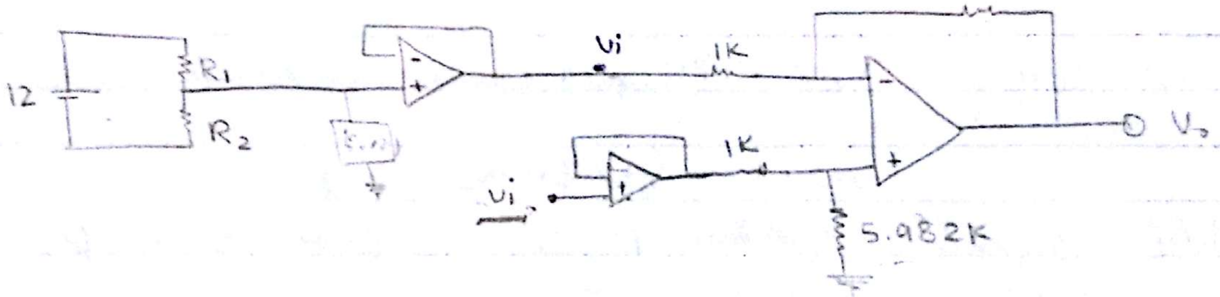
★ لما خرج الـ Sensor R(Ω) وبدي حوله V(v) لشكل Divider

★ op-Amp 〃 〃 〃 〃 I(A) 〃 〃 〃

$5.982\,(V_i - 5.021)$

V_i	5.0178	5.3519	5.686
V_o	0	2	4
	.00007	1.9762	3.973

→ التحقيق



9/Dec/2019 EE463 (7)

18. **Ex** ➡ pressure Sensor Sensitivity 1.1 mA/bar in The Range (2 ~ 18 bar) & @ 0 bar = 8.2 mA Design Signal Conditioning Circuit for ADC which Voltage Reference (0 ~ 3V) ? $\boxed{R = 100\Omega}$

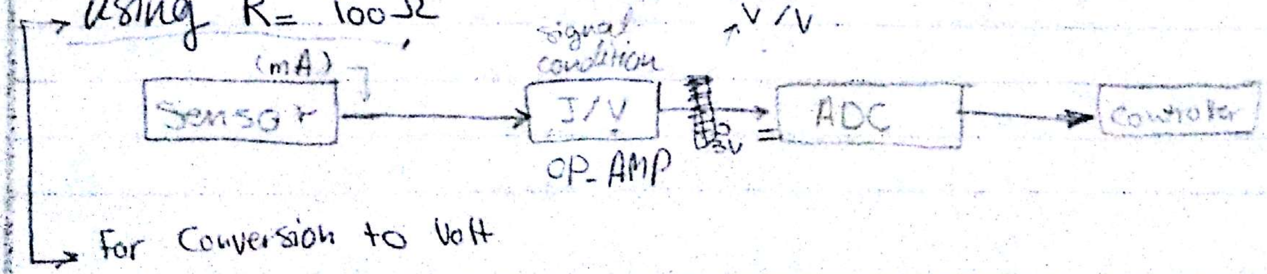
(2 ~ 18 bar) → Pressure Range

$(8.2 + [1.1 \times 2] \sim 8.2 + [1.1 \times 18])$ → Sensor O/P Range

(10.4 mA ~ 28 mA)

[ركزي 8 و جاي]

★ لو @ 2 bar = 8.2mA تصبح 2bar ← 8.2mA طول :)



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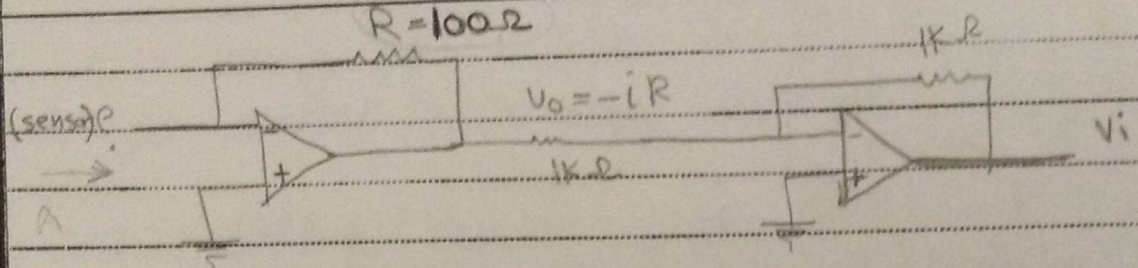


o/P Voltage Range (10.4 mA X 100 Ω ~ 28 mA X 100 Ω)

(1.04 V ~ 2.8 V)

Add signal condition to convert from V to V

$V_o = V_i M + \text{offset}$

$3 = 2.8 M + \text{offset}$ $\boxed{1}$

$0 = 1.04 M + \text{offset}$ $\boxed{2}$

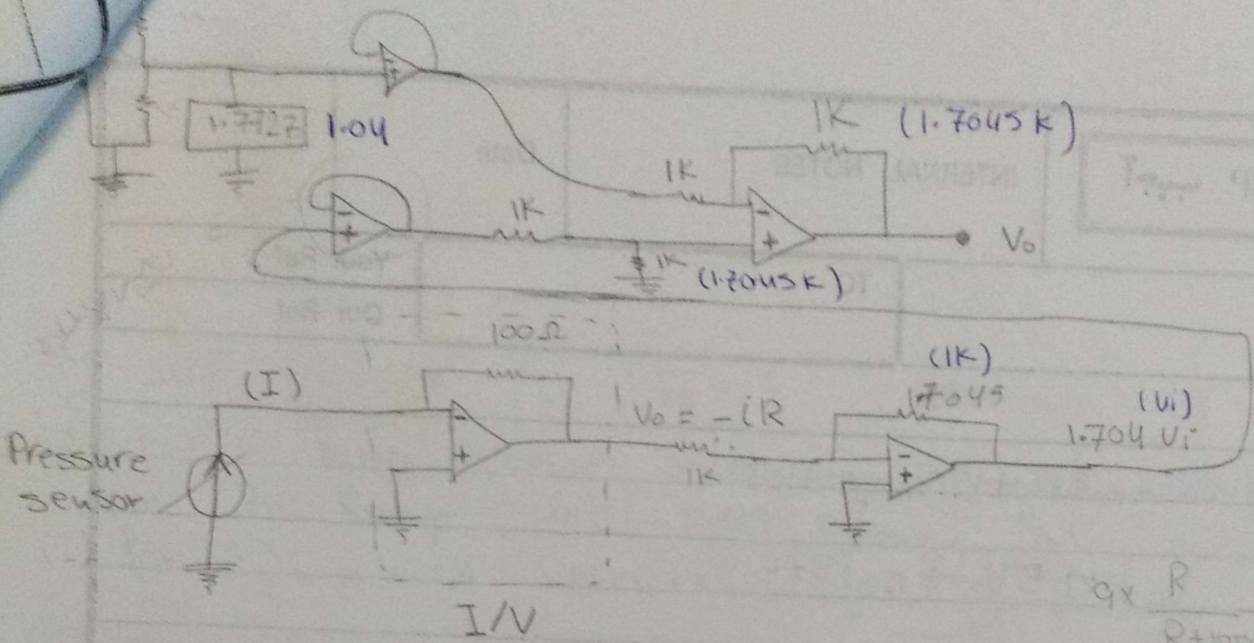
$3 = 1.76 M$ $\boxed{1-2}$

$M = 1.7045$

$\text{offset} = -1.04 * 1.7045 = 1.7727$

$V_o = V_i \, 1.7045 - 1.7727$

Vi	1.04	1.92	2.8
Vo	−0.00002	1.49994	2.9999
	0	1.5	3



$9 \times \frac{R}{R+100} = 1.77$

when you change eq The number in fig change

eq $\rightarrow$ $\boxed{V_o = 1.7045(V_i - 1.04)}$

$V_o = 1.7045\, V_i - 1.772$

19 Ex ▸ pressure sensor Sensitivity 12mV/bar in The Range (0 ~ 20bar) & @ 0 bar = -15mV Design signal conditioning cct for ADC which Voltage Reference (0 ~ 3V)

pressure Range (0 bar ~ 20bar)

sensor o/p Range $(-15mV + (0 \times 12\frac{mV}{bar}) \sim -15mV + (20 \times 12))$

$(-15mV \sim 225mV)$

no need for convert it is already Voltage o/p

$V_o = V_i M + \text{offset}$

$3 = 0.225\, M + \text{offset}$ ①

$0 = -0.015\, M + \text{offset}$ ②

$3 = 0.24\, M \implies M = 12.5$

0.1875

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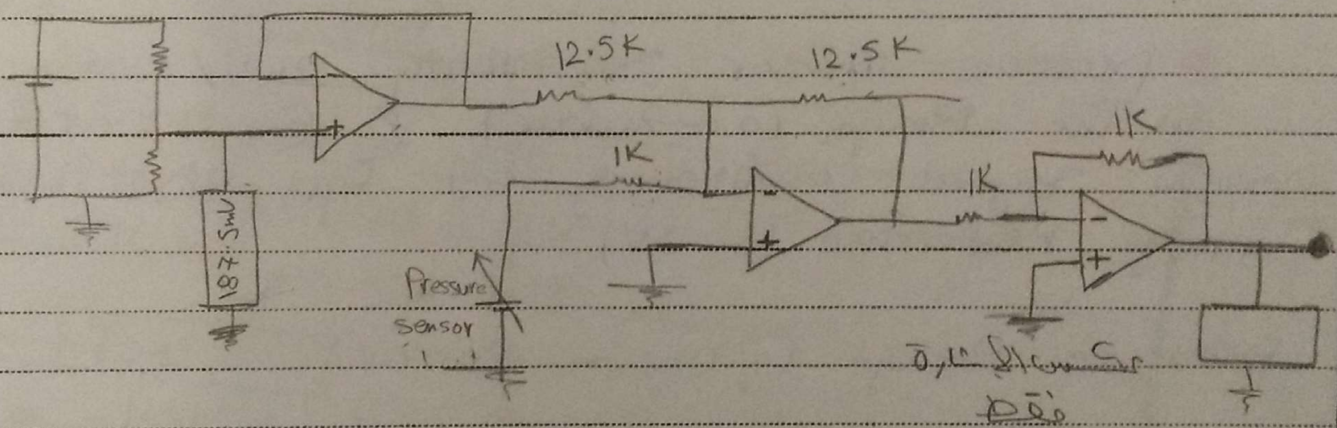
off set $= 0.015 * 12.5 = 0.1875$ V

$V_o = 12.5 V_i + 0.1875$

V_i	-15 mV	105 mV	225 mV
V_o	0	1.5	3

100% accuracy.

$V_o = \frac{R_f}{R_1}(V_1)$



a) what is The Value of The pressure if The O/P Voltage is 1.2 V ? (8 bar)

b) what is The O/P Voltage if The pressure is 7 bar ? (1.05 V)

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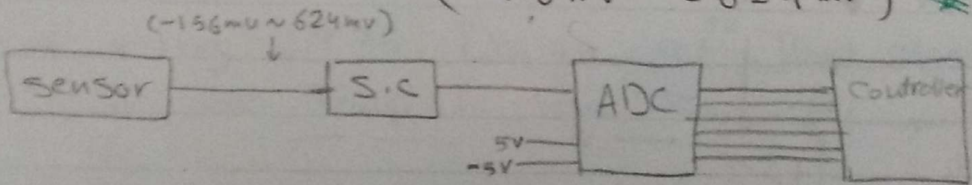
20 EX ▸ Temp Sensor Sensitivity (7.8 mv/°C) working in The Range (−20°C ~ 80°C), Design S.C ccircuit for ADC wich Reference range (±5V) signal condition

Temp Range (−20°C ~ 80°C)

Sensor O/P range $\left(-20 \times 7.8 \frac{mv}{C^\circ} \sim 80 \times 7.8 \frac{mv}{C^\circ}\right)$

(−156 mv ~ 624 mv) #



$V_o = V_i M + \text{offset}$

$5 = 624 \times 10^{-3} M + \text{offser} \rightarrow \boxed{1}$

$-5 = -156 \times 10^{-3} M + \text{offset} \rightarrow \boxed{2}$

$10 = 0.78 M \longrightarrow \boxed{1-2}$

$M = 12.8205$ #

$\text{offSet} = 5 - 624 \times 10^{-3} \times 12.8205$

$\text{offset} = -3$ #

$V_o = V_i \times 12.8205 - 3$ #

V_i	−0.156	0.234	0.624
V_o	−4.999998	-3×10^{-6}	4.999992
	−5	0	5

→ "التحقيق ضروري"

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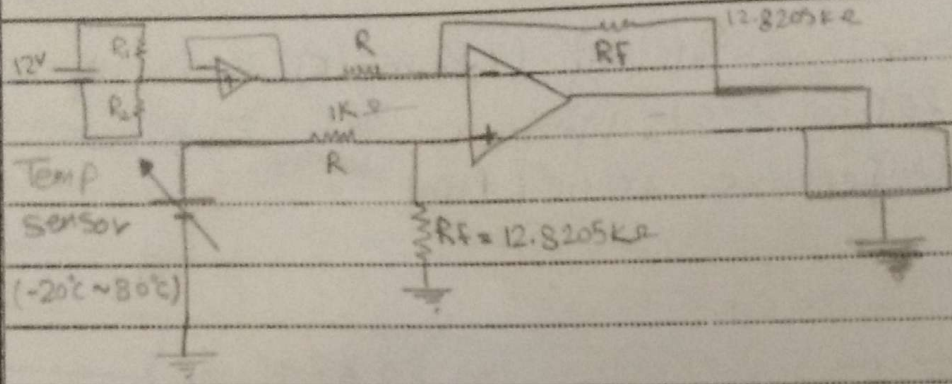
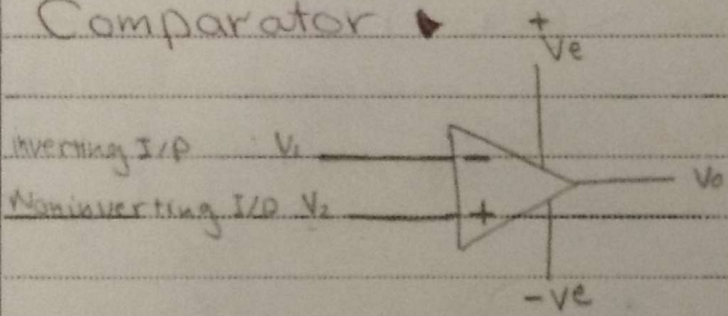


Comparator ▶



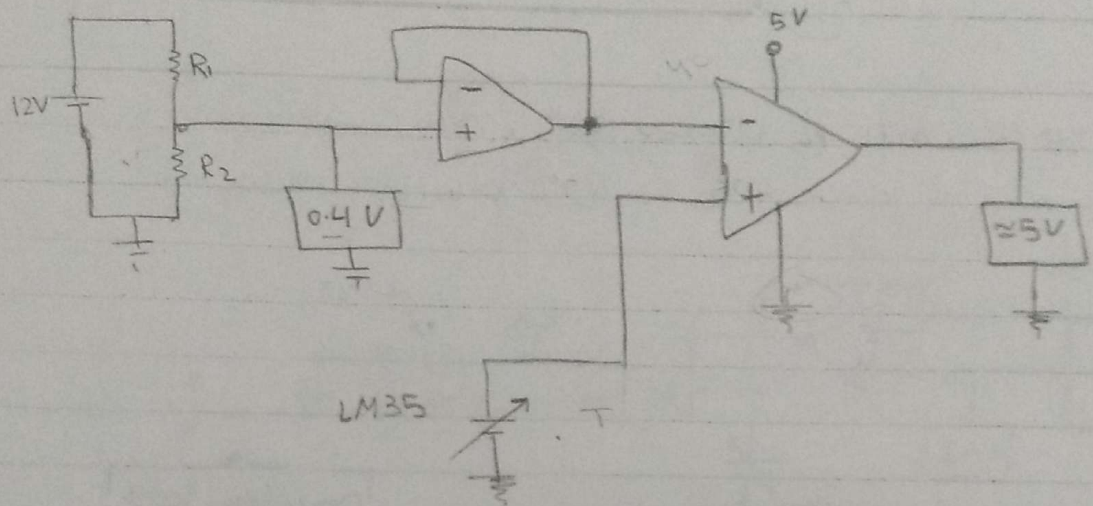
$V_1 > V_2 \Rightarrow V_o = -V_e$

$\left[V_2 > V_1 \Rightarrow V_o = +V_e \right]$

2) EX ▶ using LM35 Design CirCuit That operate Fan if The Temp is more Than 40°c.

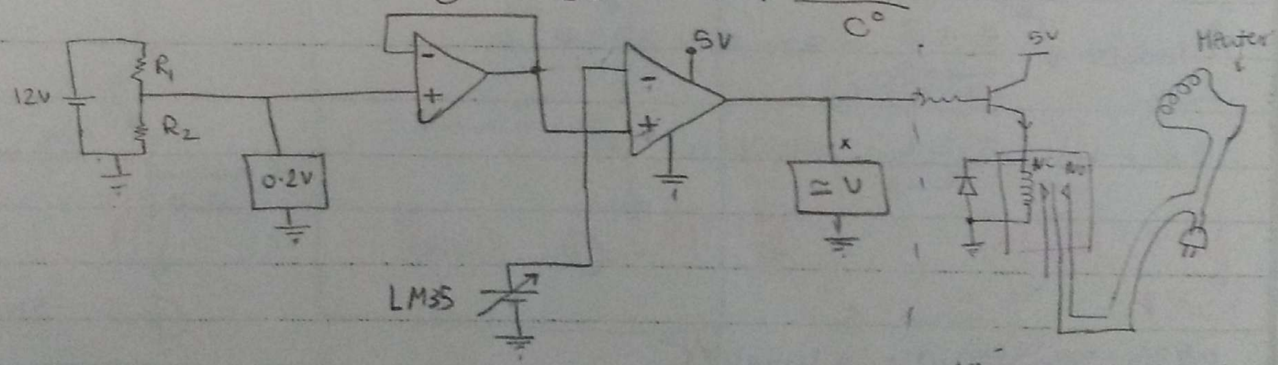
Temp Sensor o/p @ $40°C = 40°C \times \frac{10\,mv}{C°} = 400\,mV \simeq 0.4\,V$

$T > 40°C$



22 *Ex ▶ using LM 35 Design cct That operater heater if The Temp is less Than 20°c. $T<20°$

Temp Sensor O/P @ $20°C = 20°C \times \frac{10mV}{C°} = 200 mV$.



NC → normally closed.

NO → normally open.

23 Ex ▶ using lM35 Design cct That operate Red led if The Temp is less Than 18°c / blue led if The Temp is more Than 42°c / Green led if The Temp is between (18/T/42°c).

sad Sick

Questions

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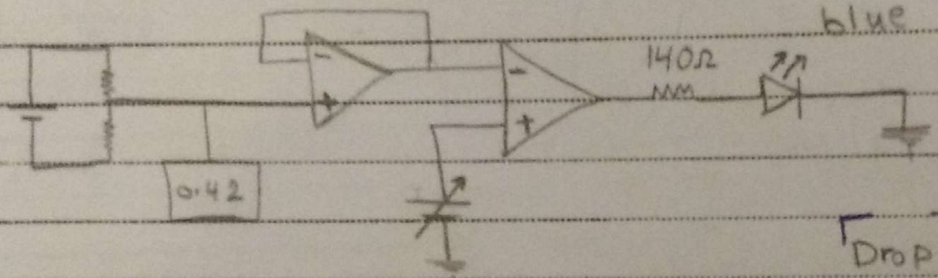
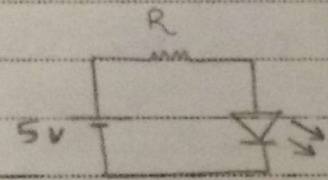
Temp sensor o/p @ 18°c = $18C^\circ \times \frac{10\,mv}{C^\circ} = 180\,mV$

" " " " 42°c = $42^\circ C \times \frac{10\,mv}{C^\circ} = 420\,mv$





20mA = Max → يا أخي شدة الإضاءة ;)

Drop on led:
- Red = 1.8 V
- blue = 3.6 V
- Green = 2.1 V

$R_{Red\_led} = \frac{5-1.8}{10mA} = 320\,\Omega \simeq 330\,\Omega$ #

$R_{blue\_led} = \frac{5-3.6}{10mA} = 140\,\Omega$ #

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24 Ex ▶

LM35, sensitivity = 10mv/C°

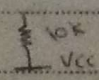
blue led if Temp is more Than 42°

Red " " " " less " 18°

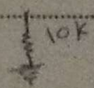
Green " is between.

So, we using NoR Gate if The blue & Red off Green Turn ON.

★ pull up ~~use~~ High, until you give it Zero → NOR



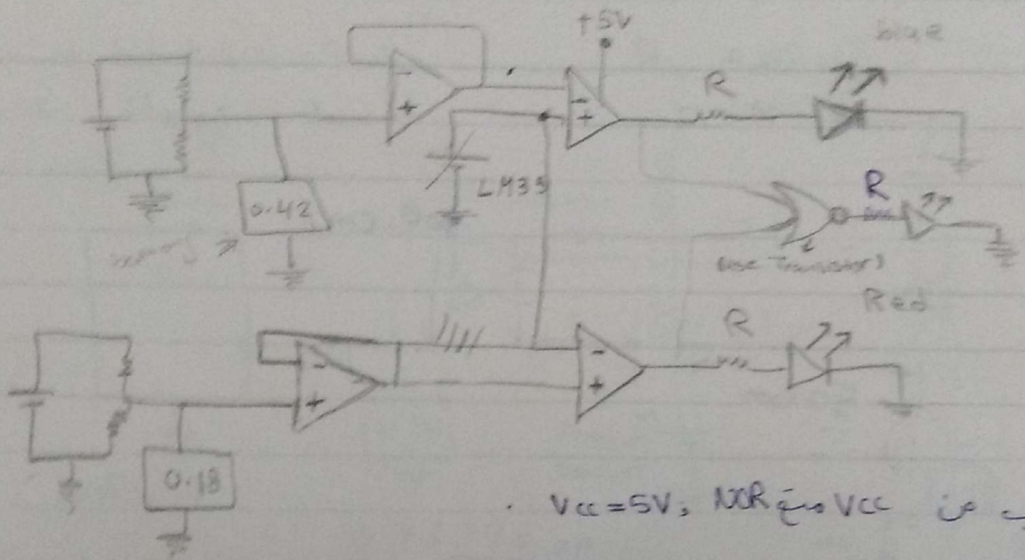
★ " Down " " " " → OR



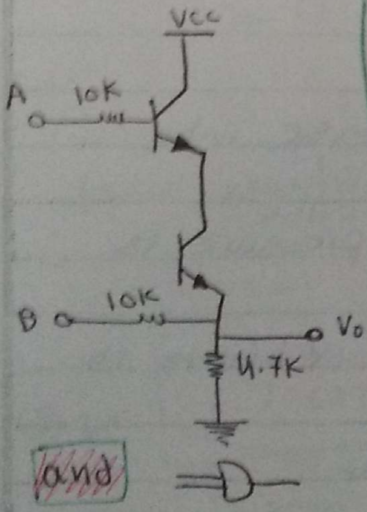
NOR 

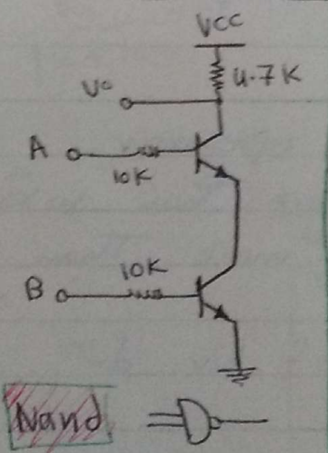
A	B	$F = \overline{A+B}$
0	0	1
0	1	0
1	0	0
1	1	0

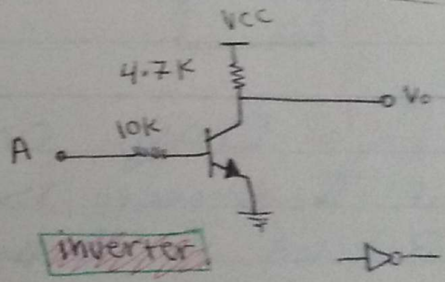
Example تطبيقات ع

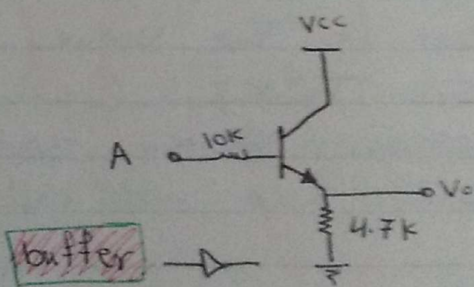


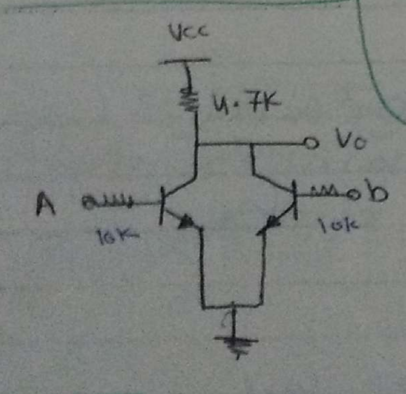
R نحسب من Vcc مع NOR ، Vcc=5V .

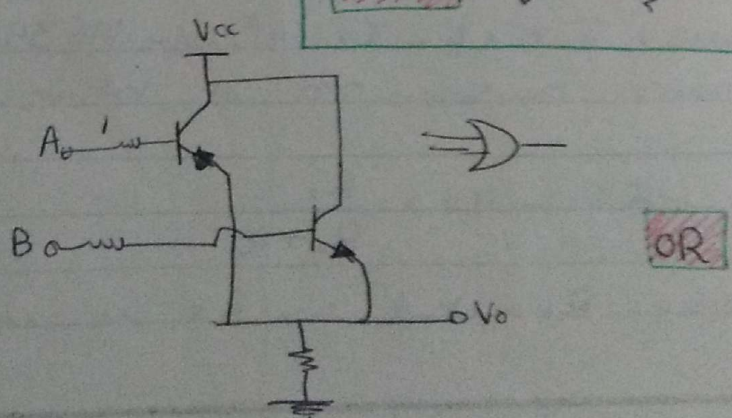












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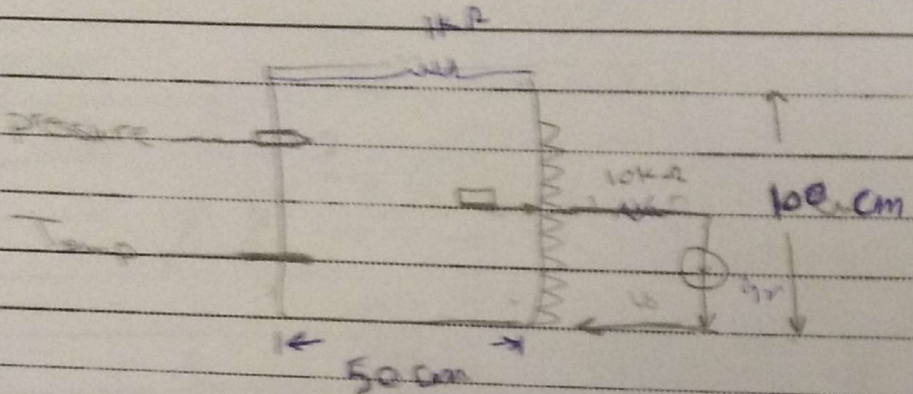
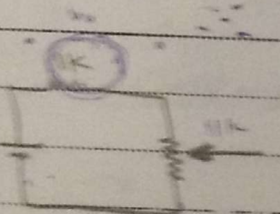




$V_s = 9V$

$\frac{9 \times 7}{7+10}$

25 Ex ▸ Design Circuit operator Release Valve if The pressure is more Than 10 bar (Release Valve) Red led if Temp is more Than 50 / Relive pressure is less Than 2 bar. OR

what is The value of V_o if is 15L (it is in The Tank)

* pressure sensor sensitivity = 20 mV/bar
* Temp " is LM35

Volume $= \pi r^2 \times h = \pi \times (25)^2 \times 100 = 196350\ cm^3 = 196.35\ L$ *

Pressure sensor O/P at 10 bar → $10\ bar \times 20\ \frac{mV}{bar}$ = → 200 mV *

$VD = 0.2\ V = 9V \times \frac{R_2}{R_2 + R_1}$

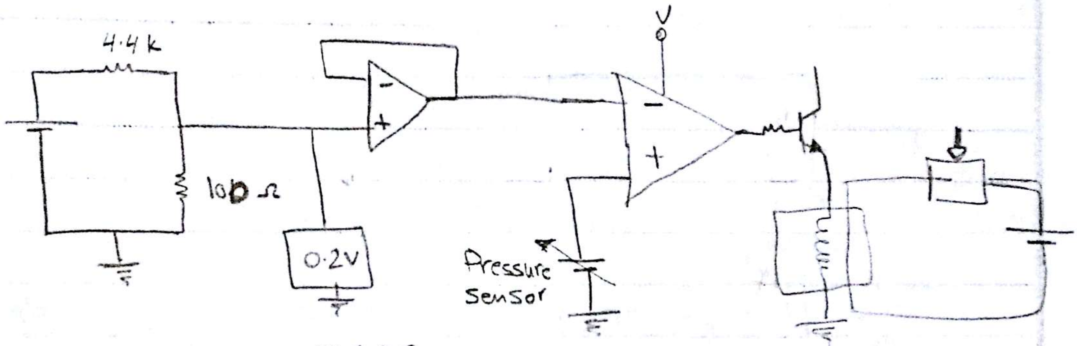
Assume $R_1 = 1K\Omega$ → i.e less current cost.

potential $\Downarrow$ vo ~~meter~~ $\to$ 2K when 20cm High

$R_2 + R_1 = 11K\Omega$

$0.2 R_2 + (1K * 0.2) = 9V R_2 \rightarrow R_2 = 22.7\Omega$ # X

$R_1 = 4.4K \quad R_2 = 100\Omega$



0.7639

$$V_0 = 9V \times \frac{R_2}{1K + 10K}$$

$$\pi r^2 \times h = 1500 \text{ cm}^3$$

196.35 / 1000cm

1000 cm³ → 1L

15L

① $\boxed{h = 7.639 \text{ cm}}$ 20cm

0.7639 k 2K

$$V_0 = \frac{9 \times 7.639}{11k}$$

H > 80cm Led → ON

③ $V_0 = \boxed{0.625}$ #

② $\boxed{763.9\Omega}$

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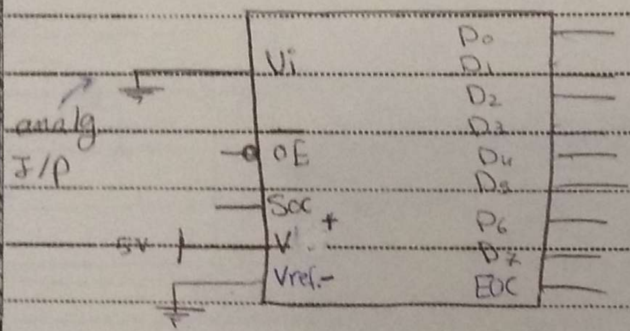
Analog to Digital Converter ▸ (ADC)



unipolar (0~5V) / (-5~0V)

bipolar (±5V) , (±3V)

OE ▸ output Enable

SOC ▸ Start of Conversion

$D_0 \sim D_7$ ▸ Digital O/P

EOC ▸ End of Conversion

$$\text{Resolution } (\Delta V) = \frac{V_{ref}^{+} - V_{ref}^{-}}{2^n} = \frac{5}{2^8} = 19.53125 \times 10^{-3}$$

$$\text{Digital O/P} = \frac{\text{analog I/P}}{\Delta V}$$

26 Ex ▸ What is The digital O/P, if The I/P is 1.85V ?

$$\text{Digital O/P} = \frac{1.85}{19.53125\times10^{-3}} = 94.72 \simeq 95$$

128	64	32	16	8	4	2	1
0	1	0	1	1	1	1	0

27 EX ▶ what's The analog I/P, if Digital O/P 01011000

$$\text{analog I/P} = \text{Digital o/P} \times \Delta V$$
$$= 88 \times 19.53125\ mV$$
$$= 1.71875\ \#$$

28 EX ▶ using LM35D in The Range $(20 \sim 115^\circ C)$ design S.C cct for $(0 \sim 4\ V)$ Voltage Reference ADC:

a] what is The digital O/P if The Temp$(37^\circ C, 107^\circ C)$
b] what is Temp if The digital O/P is $(01010101)_2$?

Sensor O/P Range $\left(20 \times 10\frac{mV}{C^\circ} \sim 115 \times 10\frac{mV}{C^\circ}\right)$

$$(0.2V \sim 1.15V)$$

$$V_o = m\ V_{in} + \text{offset}$$
$$0 = m\ 0.2 + \text{offset} \quad ①$$
$$4 = m\ 1.15 + \text{offset} \quad ②$$
$$② - ① \quad 4 = m\ 0.95$$

$$m = 4.21052$$
$$\text{offset} = -0.8421$$

$$V_o = 4.21052\ V_i - 0.8421 *$$

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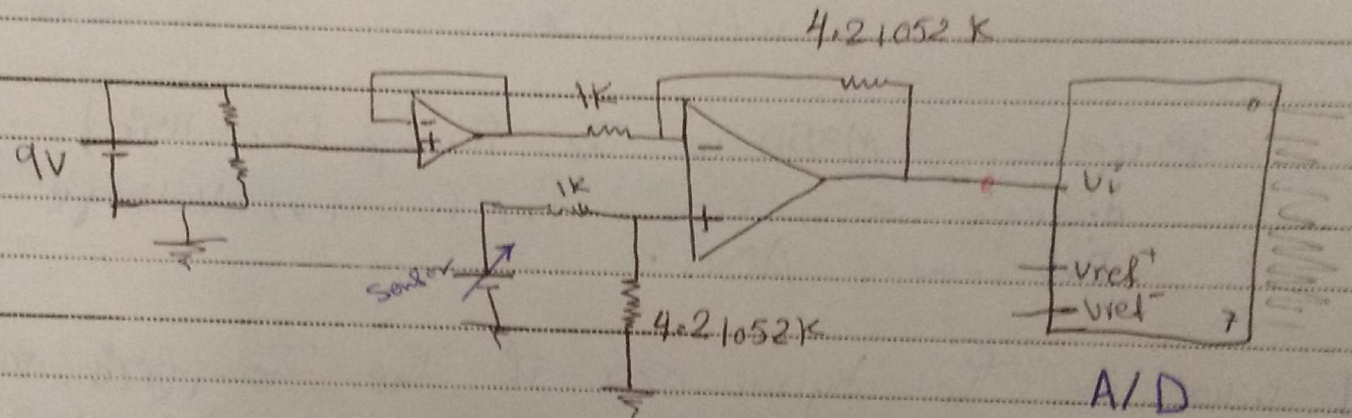
Vi	0.2	0.675	1.15
Vo	4 μV	2.60005	3.99999
	0	2	4

$V_o = 4.21052\,(V_i - 0.2)$ ✓



$\Delta V = \dfrac{4\,V}{256} = 0.015625\,V$

$\text{Digital o/p} = \dfrac{\text{analog IP}}{\Delta V} = \cancel{2216221024}$

@ 37°C

Sensor o/p = 37°C × 10 = 370 mV ✓

$V_o = 4.21052\,(0.37 - 0.2) = 0.7158\,V$

~~ΔV~~ $\text{Digital o/p} = \dfrac{0.7158}{0.015625} = 45.8107 \simeq 45$

128 64 32 16 8 4 2 1
$(0\ 0\ 1\ 0\ 1\ 1\ 0\ 1)_2$ //

@ $107^{\circ}C$

sensor O/P = $107^{\circ}C \times 10\,mV = 1.07\,V$

$V_o = 4.2105\,(1.07) - 0.8421 = 3.663135\,V$

$D.O = \frac{3.663135}{0.015625} = 234.44 \simeq 234$

128 64 32 16 8 4 2 1
$(1\ 1\ 1\ 0\ 1\ 0\ 1\ 0)_2$ #

b) $(01010101)_2 = (85)_{10}$

analog I/P = 1.328125

$1.328125 = 4.2105\,V_i - 0.8421$

$V_i = 0.51543\,V$

$T = 0.51543 / 10\,mV$

$51.54^{\circ}C$

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Subject 29 EX ▸

using Accelormeter which Sensitivity (0.13 mA / g) at 0g = 1.9 mA in The Range (∓ 15g) design Signal condition cct for ∓ 3V Voltage reference R = 200 Ω.

for digital o/P (unpolar) = $\frac{\text{analog I/P}}{\Delta V}$

$\Delta V = \frac{V_{ref}^{+} - V_{ref}^{-}}{2^n} = 0.02344$

Shift لأنه الناتج بالسالب لازم نزيد

input	output
	1111 1111 → 255 , 2^8 = 255
−3	0000 0000
$-3 + \Delta V = -2.9766$	0000 0001
$-3 + 2\Delta V = -2.9331$	0000 0010

EX ▸ analog I/P = 1.5 V

$\frac{1.5 + 3}{23.43 \times 10^{-2}} = 192$

analog i/p = 0 → 256/2 = 128 *

Digital o/P (bipolar) = $\frac{\text{analog I/P} + V_{ref}^{+}}{\Delta V}$

a). what is The digital o/P if The i/P is 3.8 g (95)

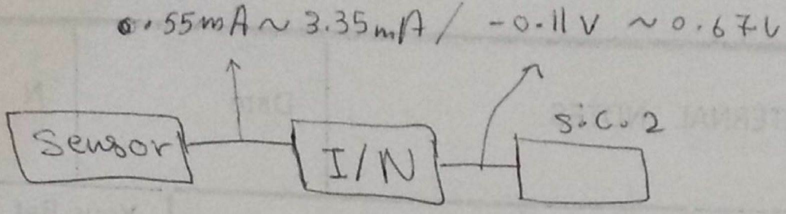
b). what is The accelaration if The digital o/P (1001 0010). → $(146)_{10}$

(2.078 g)

aug ↓ 1.5

$\frac{\text{analog} + V_{ref}^{+}}{\Delta V} = 146.$

analog + V_{ref}^{+} = 3.421 , analog = 0.421.



$V_i = 0.3347$
$I_i = 1.6736$ mA
$\theta = 0.01278$ g

range (15g ~ -15g)
range O/P Sensor (-0.55 ~ 3.35 mA)
O/P Voltage (-0.11 V ~ 0.67 V)

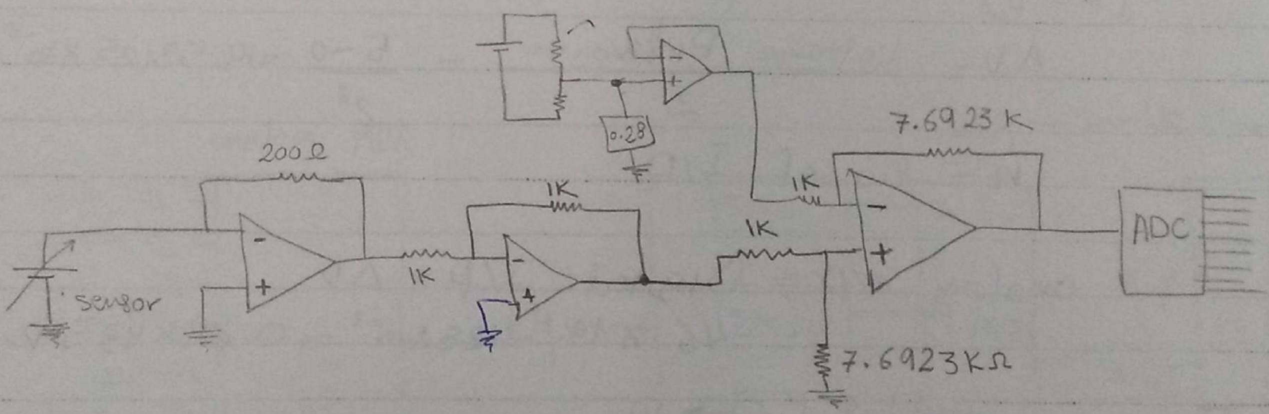
$V_o = MV_i + offset$
$3 = 0.67M + offset$
$-3 = -0.11M + offset$

$M = 7.6923$, $offset = -2.1538$

$V_o = 7.6923(V_{in} - 0.27999)$

$V_o = 7.6923\,V_{in} - 2.1538$

Vi	-0.11	0.28	0.67V
Vo	2.999	4.4×10^{-5}	3.00004



$\Delta V = 0.023437$

$$\text{Digital O/P} = \frac{\text{analog} + V_{ref}^{+}}{\Delta V}$$

(a) $-3.8 \rightarrow 0.494$ mA ~ $\overset{0.906}{\overset{11.4}{}\cancel{0.494}} \times 200$ ~ $-\overset{181.2}{98.8}$ mV =

$\overset{0.1812}{\cancel{-0.0988}}$ V $\longrightarrow V_o = 7.6923 \times (-0.0988) - 2.1538$ $\boxed{95.5116}$

$V_o = \cancel{-2.913794}$, Digital O/P = $\cancel{3.677948}$
-0.76149 ~4

~~0000 0100~~
1011 1111

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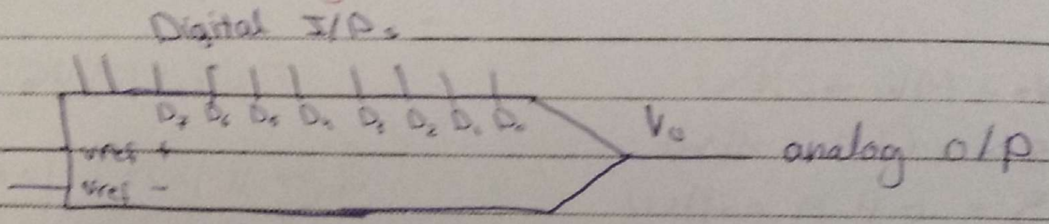
Digital to analog Converter ▸



2) EX ▸ what is The Value of analog O/P if The digital I/P is $(10110)_2$ & The Voltage Reference is between (0~5)v ?

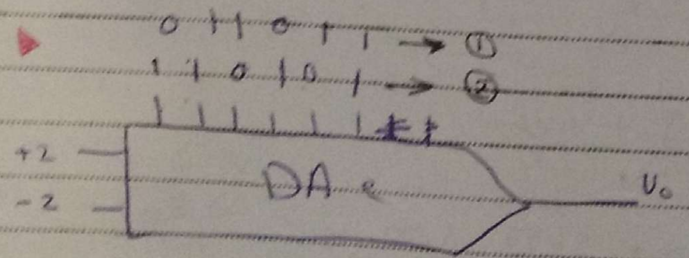
$$\Delta V = \frac{\text{Voltage Reference}}{2^n} = \frac{5-0}{2^8} = 19.53125 \times 10^{-3}$$

n = no. of. I/P

EX ▸ analog o/P = Digital I/P * ΔV

$$= 46 \times 19.53125 \times 10^{-3} = 0.898435 \text{ v.}$$

3) EX ▸



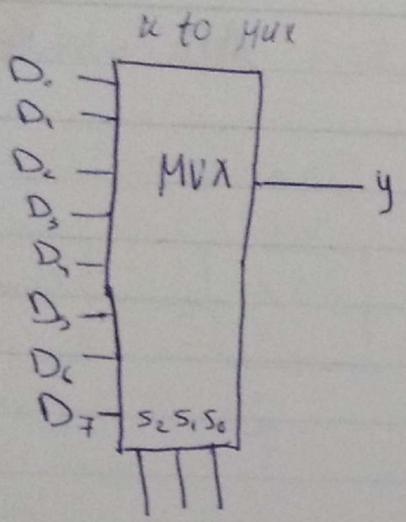
$$\Delta V = \frac{4}{2^6} = 0.0625 \text{ V}$$

① $= (27 \times 0.0625) - 2 = -0.3125$ v

② $= (53 \times 0.0625) - 2 = 1.3125$ V

(Digital I/P * ΔV) − Vref* = analog O/P

Data Selector



0 1 2 3 4 5 6 7

10110100

$S_2\ S_1\ S_0$

1 1 0

$y = D_6$ ☺

CMOS

$0 \triangleq$ Ground

(   )

$5 \triangleq 1$

(   )

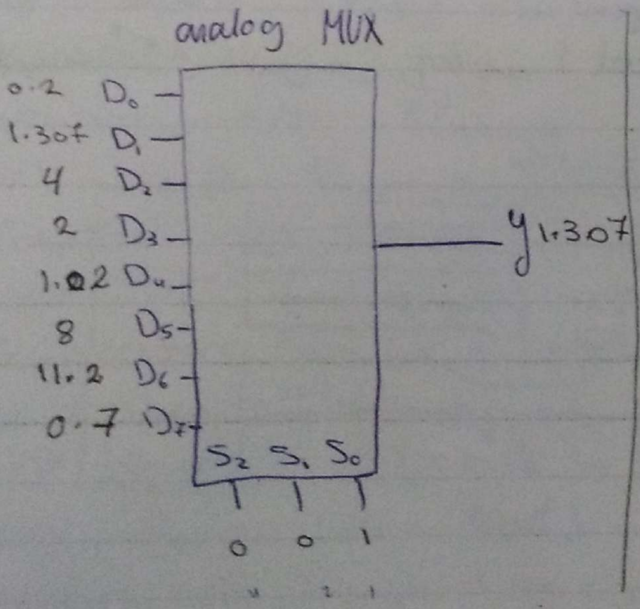
TTL

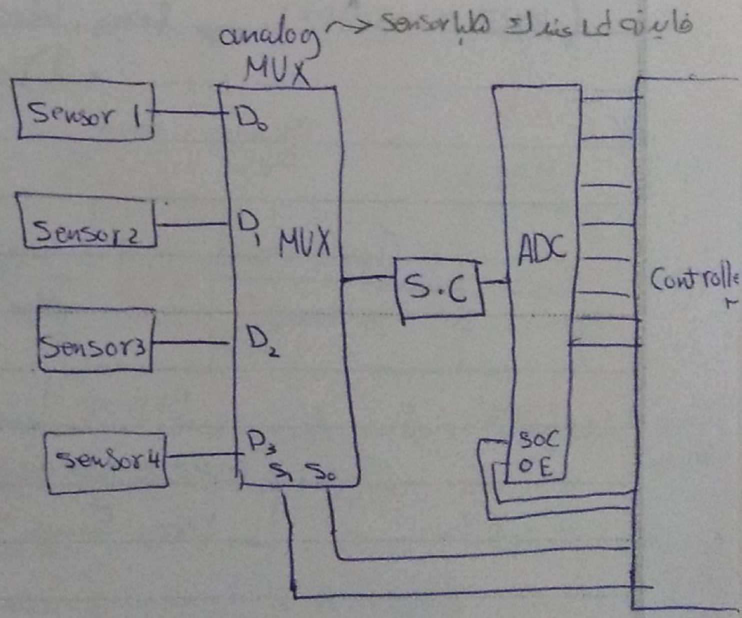
$5V \triangleq 1$

$(2 \sim 5.5)$

$0 \triangleq$ Ground

$(0 \sim 0.8)$





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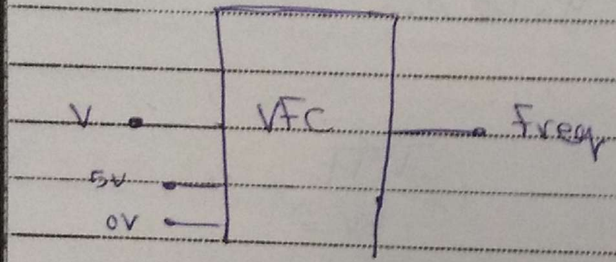
Voltage to Freq Converter : (VFC) AD method(2)



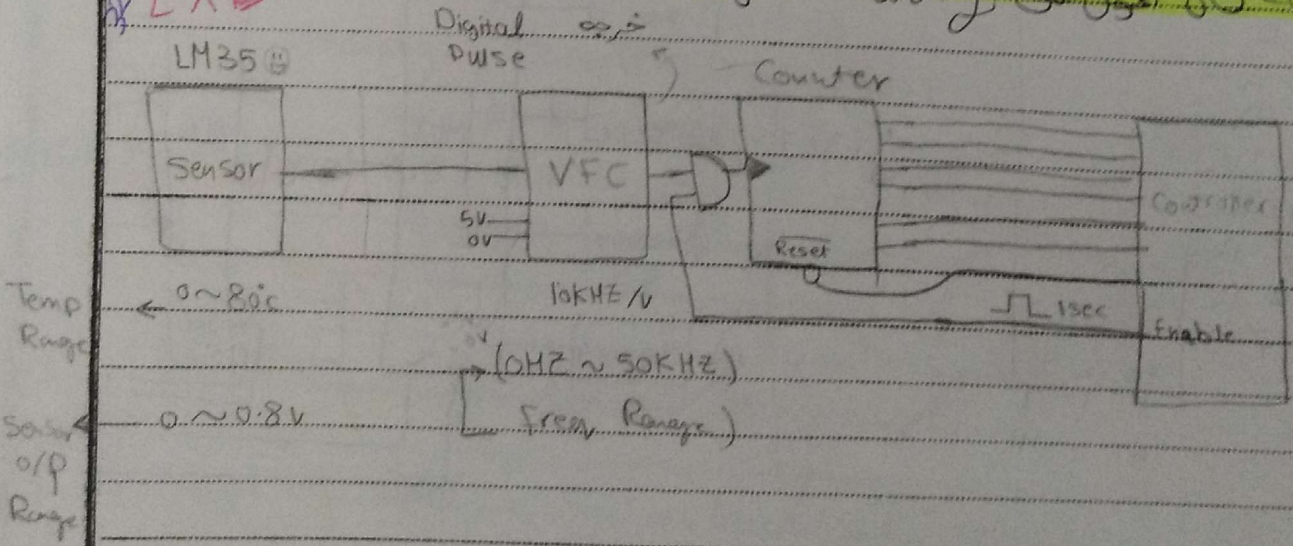
[10 KHZ /V] → Rate

(0V ~ 5V) → Voltage Range.

(0HZ ~ 50 KHZ) → freq Range.

• وظيفته "كأنه" أحول من analog لـ Digital *

EX ▶



@ 20°C ⇒ 0.2V | $0.2V \times 10 \frac{KHZ}{V} = 2KHZ$

Scanned by CamScanner

@47°c 10mv/c° | 5KHZ /V | duration(0.2 s) | What's o/p of Controller

@47°c → 0.47 V | $0.47 \times 5\frac{KHZ}{V} = 2.35KHZ$ | $0.2 \times 2350 =$ 470 pulse | Exam Q

33 EX ▶

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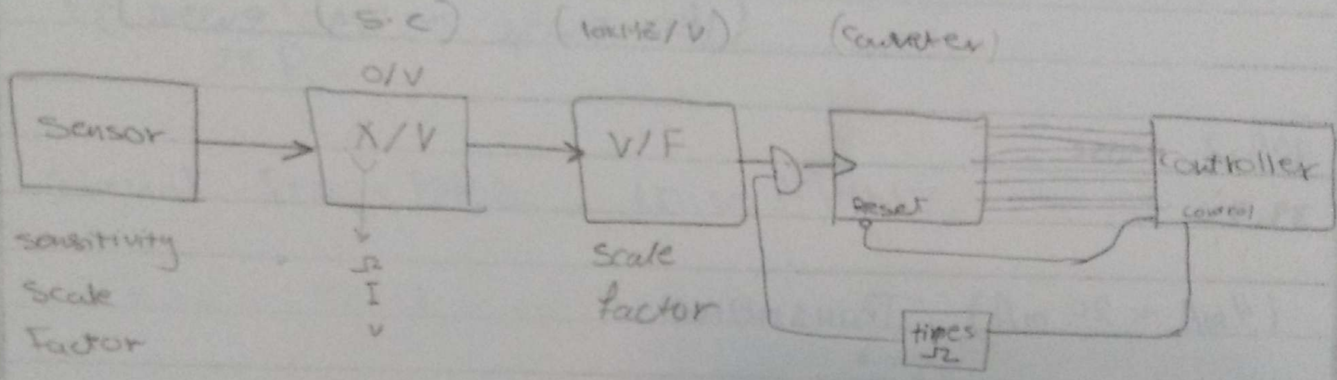

34 EX ▶ using Lm35 for the Range (30° ~ 90°c) and using (V/f) which scale factor (3KHZ/V) calculate :

(a) sensor o/P Range
V/f o/P Range
Counter o/P Range (using 0.2 s duration)

(b) what is the digital o/P of the Counter if the Temperature is 68.2 °?

(c) what is the Value of Temprature if f.v digital o/P (counter) is $(0011\,1011\,01)_2 \equiv (237)_{10}$.

temp Range (30 ~ 90°c)

sensor o/P Range $(30 \times 10\frac{mv}{c}) \sim (90 \times 10\frac{mv}{c})$

$(0.3V \sim 0.9V)$

V/f o/P Range $(0.3V \times 3\frac{KHZ}{V} \sim 0.9V \times \frac{3KHZ}{V})$

$(0.9KHZ \sim 2.7KHZ)$

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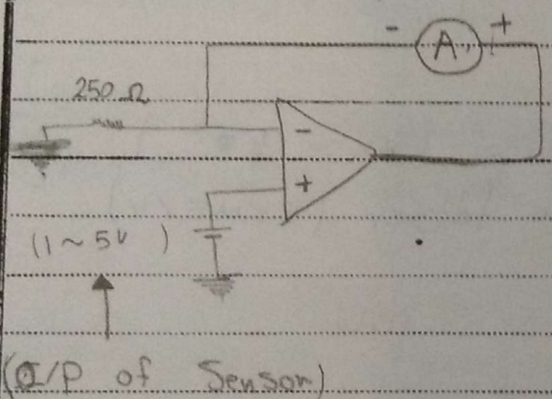
Counter o/P Range (0.9 KHZ $\times$ 0.2 s ~ 2.7 KHZ $\times$ 0.2 s)

(180 pulse ~ 540 pulse)

(b) 409.2 Pulse.

(c) 39.5°C.

(4mA ~ 20 mA) Transmitter :



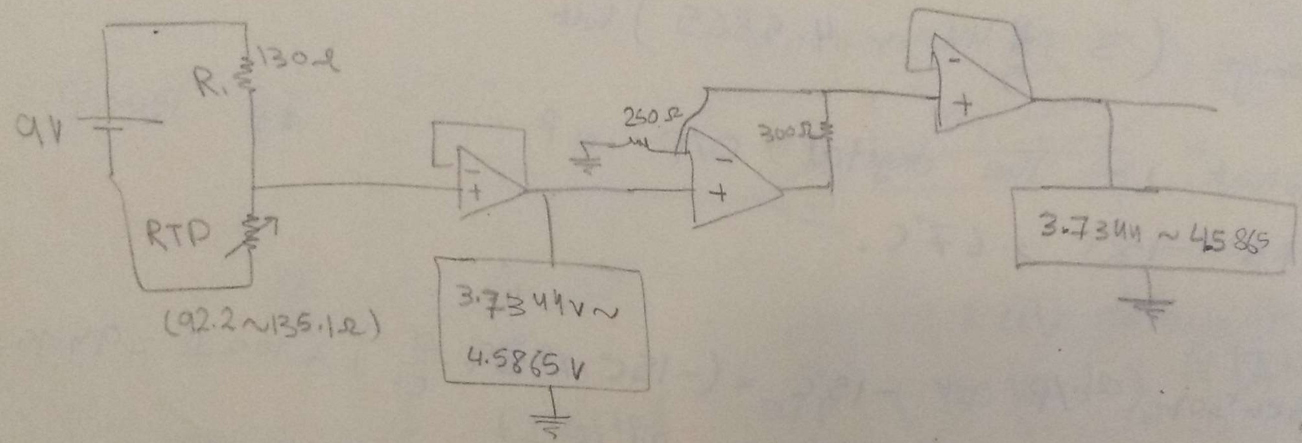
بيوصل الـ Current كـ Data
هاذي مهمة.

Sensor → S.C → 0~0.7 → S.C. → 4mA ~ 20mA Transmitter 1~5V → A/D

EX ▶

LM35 Sensor (0 ~ 80°C) → 0 ~ 0.8 V → S.C S_o + 1V → 1V ~ 1.8V → 4mA ~ 20mA Trans (1 ~ 5V) → 1 ~ 1.8V → A/D

Ex: using RTD PT100 for Temp Range $(-20^\circ \sim 90^\circ)$ in Voltage Devider with $R_1 = 130\,\Omega$ design Circuit to get The Temperature information for long distance to ADC wich Voltage Reference (± 2) Volt



Solution: Temp Range $(-20^\circ \sim 90^\circ)$

sensor o/P $[100\,\Omega + (0.39\,\Omega/^\circ C \times -20^\circ C)] \sim [100 + (0.39 \times 90)]$

$(92.2\,\Omega \sim 135.1\,\Omega)$

Voltage devider o/P Range

at $-20^\circ \rightarrow \quad V_o = 9 * \frac{92.2}{92.2 + 130} = 3.7544$ Volt

at $-90^\circ C \rightarrow \quad V_o = 9 * \frac{135.1}{135.1 + 130} = 4.5865$ Volt

$$-\begin{cases} -2 = 3.7544\,M + \text{offset} \\ +2 = 4.5865\,M + \text{offset} \end{cases}$$

$4 = M$

$M = 4.6943$

(1)

off set = -19.5308

$V_o = 4.6943\ V_i - 19.5308$

$V_o = 4.6943\ (V_i - 4.16055)$

V_i	3.7344	4.16055	4.5865
V_o	-2.009	0	1.99994

Range (3.7345 ~ 4.5865) Volt

(A) what is The digital O/P of if Temp is $-15^\circ C$, $67^\circ C$.

Solution (A) :

Sensor o/P at $-15^\circ C$ $= \left(-15C^\circ \times 0.39 \frac{\Omega}{C^\circ}\right) + 100\ \Omega = 94.15\ \Omega$

Voltage Devider o/P $= 9 \times \frac{94.15\ \Omega}{130 + 94.15} = 3.78022\ V$

Transmitter O/P = 3.78022 (because in The Range)

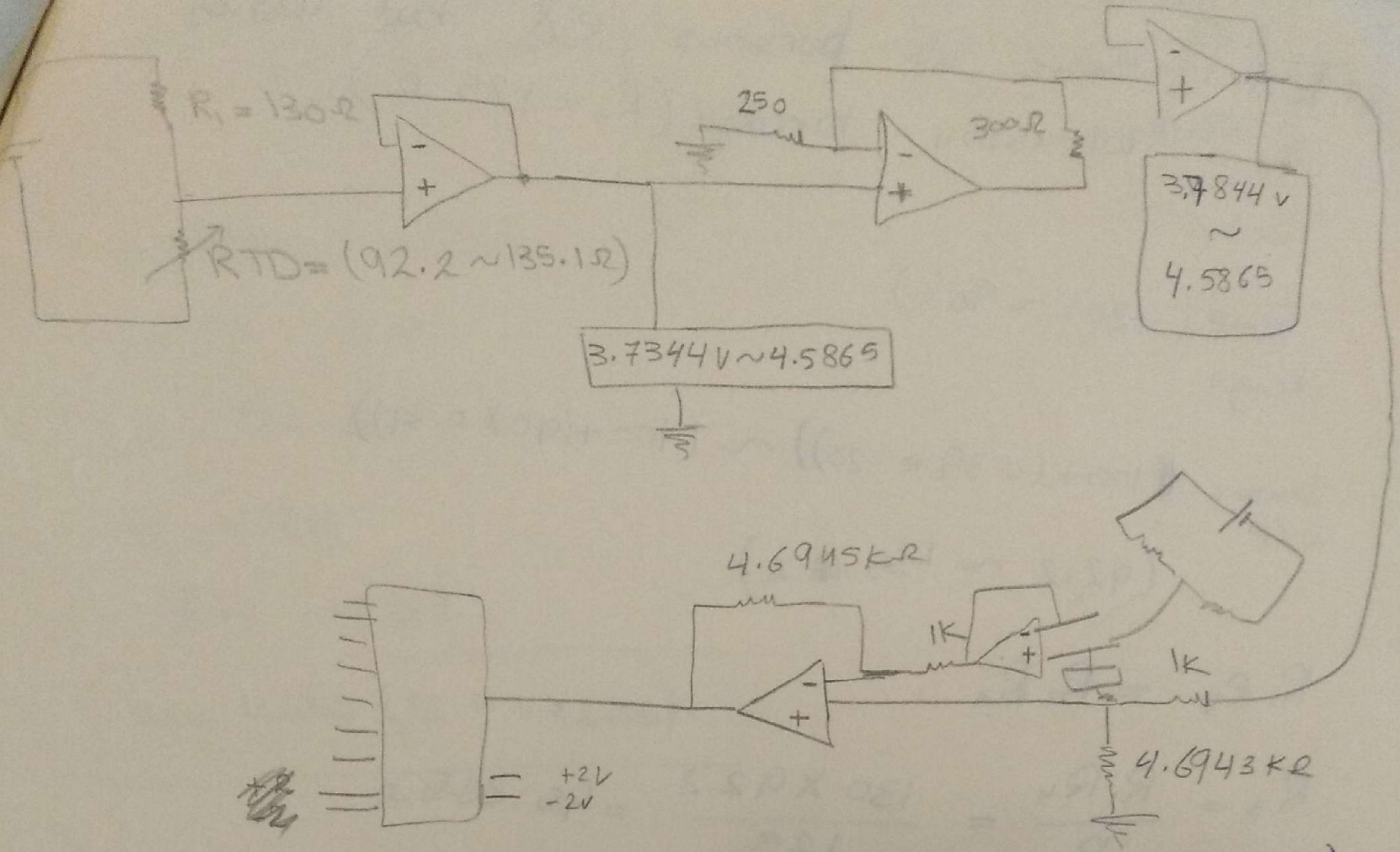
S.C O/P $= (3.78028 - 4.16055)\,4.6943 = -1.78509\,v$

$\Delta V = \frac{2-(-2)}{2^8} = 0.015625\,v.$

Digital O/P $= \frac{\text{Analog i/P} + V_{out}}{\Delta V}$

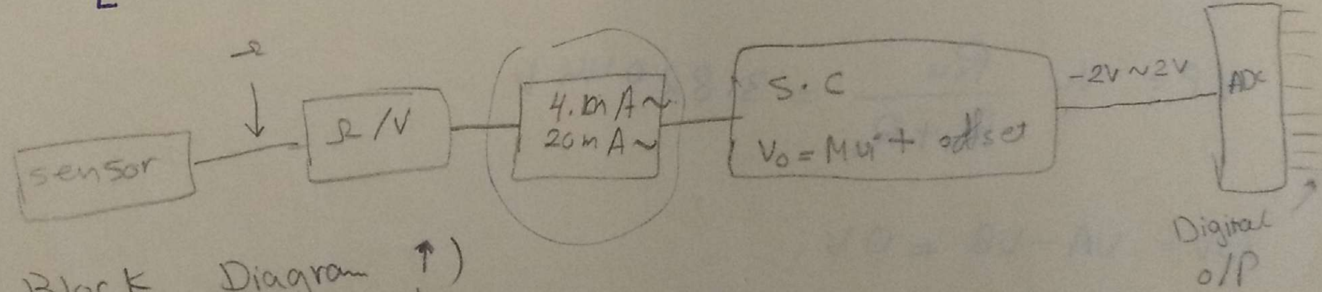
$= \frac{-1.78509 + 2}{0.015625}$

$= 13.75 \simeq 13 \rightarrow (0000\ 1101)_2$



(B) Temp if Digital o/P $(11011010)_2 \triangleq (218)_{10}$

[71.09°C] ✓



(Block Diagram ↑)

بيجيك علينا غش بالعكس

المطالب في (B)

EX : Same as pervious eX but using wheaston bridge ($R_2 = 125\,\Omega$)

Solution :

Temp Range $(-20^\circ c \sim 90^\circ c)$

Sensor o/P $((100+(0.39 * -20)) \sim (100+(90 \times 0.39))$

$(92.2 \sim 135.1\,\Omega)$

$$R_1 R_4 = R_2 R_3$$

$$R_3 = \frac{R_1 R_4}{R_2} = \frac{130 \times 92.2}{125} = 95.888\,\Omega$$

@ $-20^\circ c$

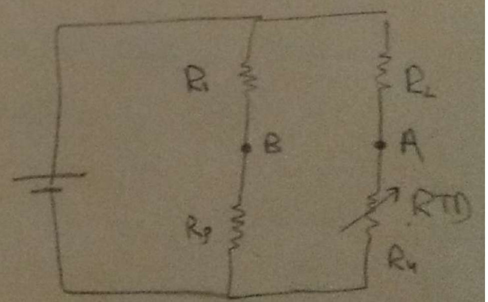
$$V_B = V_S \frac{R_3}{R_1 + R_3} = 3.82044\,V$$

$$V_P = V_S \frac{R_4}{R_4 + R_2} = 3.82044\,V$$

$$\Delta V = V_A - V_B = 0\,V$$

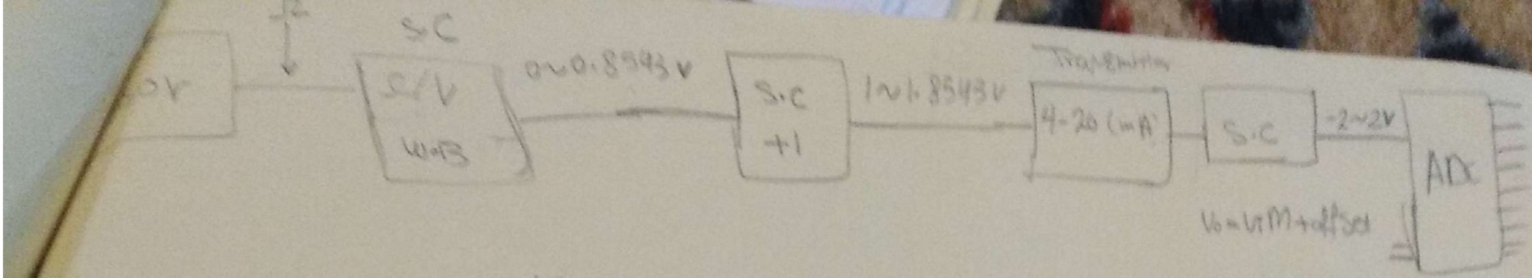
@ $90^\circ c$

$$V_D = 9 \times \frac{135.1}{135.1 + 130} = 4.6747\,V$$



$$\Delta V = 0.8543\,V.$$

bridge Range $(0 \sim 0.8543\,V)$



$$2 = 1.8543\,M + offset$$

$$-2 = 1\,M + offset$$

$$4 = 0.8543\,M$$

$$M = 4.6821$$

$$offset = -6.682$$

$$\boxed{V_o = 4.6821\,(V_i - 1.42716)}$$

lect in yellow paper

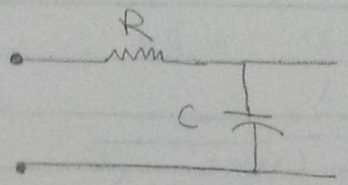
27/1/2019

lect (15)

Filters:

- low pass Filter:

$$F_C = \frac{1}{2\pi RC}$$



- Signal freq: 1KHZ , Noise: 1MHZ ?

$F_C =$ 2KHZ or 5KHZ !!

$* V_o / V_i = \frac{1}{\sqrt{1 + \left(\frac{F_N}{F_c}\right)^2}}$!!

38 **EX** ▸ The Signal freq (t_s) is 1KHZ & undesired noise signal 1MHZ (t_N). Design filter That attenuate the noise to 1% , and what is The effect of The filter on The desired Signal?

Solution:

$$\frac{V_o}{V_i} = \frac{1}{\sqrt{1 + \left(\frac{f_N}{f_c}\right)^2}}$$

$$0.01 \quad \frac{1}{\sqrt{1 + \left(\frac{10^6}{f_c}\right)^2}} \implies F_C = 10\,000.5 \text{ HZ}$$

The effect on The Signal: $\frac{V_i}{V_o} = \frac{1}{\sqrt{1 + \left(\frac{F_s}{f_c}\right)^2}}$

AgiP آجيب

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$$\frac{V_o}{V_i} = \frac{1}{\sqrt{1+\left(\frac{\cancel{1KHz}}{10.5\ MZ}\right)^2}} = 0.99503 \Rightarrow \cancel{99\%}$$

99.503 %

from The Signal.

let C = 0.1 μF

$$R = \frac{1}{2\pi * 10000.5 * 0.1\times10^{-6}} = 159.146\ \Omega.$$

$\boxed{160\ \Omega}$

قيم مقاومات التجارية 5% = ٥٪

1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.8	2	2.2
2.4	2.7	3.0	3.3	3.6	4.3	4.7	5.1	5.6	6.2
6.8	7.5	8.2	9.1						

ومضاعفاتهم

when R = 160 Ω

$$f_c = \frac{1}{2\pi\times160\times0.1\times10^{-6}} = 9947\ MZ.$$

$$\frac{V_o}{V_i} = \frac{1}{\sqrt{1+\left(\frac{1000}{9947\ MZ}\right)^2}} = 0.99489 \Rightarrow 99.489\ \%$$

$\frac{1}{0.99489} = 1.005 \rightarrow$ Gain ★ to Get back The Freq & all pervious value

when R = 180

$$F_c = \frac{1}{2\pi * 180 * 0.1 * 10^{-6}} = 8841.94 \text{ HZ}$$

$$\frac{V_o}{V_i} = \frac{1}{\sqrt{1 + \left(\frac{1000}{8841.94}\right)^2}} = 0.99366 \Rightarrow 99.366\,\%$$

$$\text{Gain} = \frac{1}{0.99366} = 1.006$$ ✓

(16) EE 463 30/1/2020

EX

Signal freq 2KHZ, Noise 110 KHZ at [1% Noise attenuation.]

$$0.01 = \frac{1}{\sqrt{1 + \left(\frac{110\text{ KHZ}}{F_c}\right)^2}} \Rightarrow F_c = 1.1 \text{ KHZ}.$$

effect on the signal. $\frac{V_o}{V_i} = \frac{1}{\sqrt{1 + \left(\frac{2\text{KHZ}}{1.1\text{KHZ}}\right)^2}} = 0.4819$

which is very bad $\Rightarrow 48.19\,\%$

② • up to 5% Noise attenuation.

88 9.9 11

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$$0.05 = \frac{1}{\sqrt{1+\left(\frac{110KHZ}{fc}\right)^2}} = 5.5KHZ$$

effect on the Signal = 0.939 which is better

لازم تعلق !!

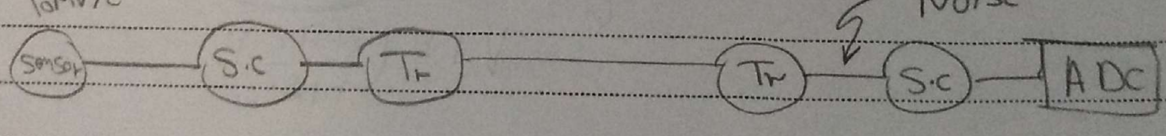
(3) up to 7% Noise attenuation

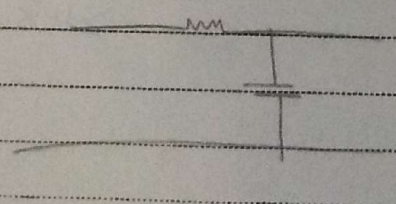
$$0.07 = \frac{1}{\sqrt{1+\left(\frac{110KHZ}{fc}\right)^2}} = 7.71KHZ$$

effect on the Signal = 96.8%

$$Gain = \frac{1}{0.968} = 1.033$$

* when Noise attenuation up to 10%, $f_c = 11KHZ$, effect = 98.38%

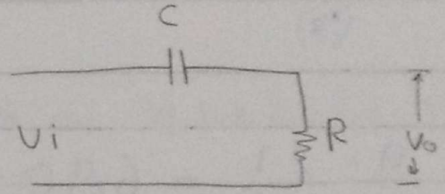




{3 itreation in exam}

- **High pass Filter ▸**
  يمرر الأعلى منه , low Ss عكس [$F_s > F_c$]

$$\frac{V_o}{V_i} = \frac{F / F_c}{\sqrt{1 + \left(\frac{F}{F_c}\right)^2}}$$



EX ▸ Noise 50 HZ , Signal 1KHZ (Select / design) The Filter Circuit & Calculate The effect on The Signal.

Solution :

$$0.01 = \frac{50HZ / F_c}{\sqrt{1 + \left(\frac{50}{F_c}\right)^2}} = 5KHZ \rightarrow [\text{at } 1\%]$$

which is very bad because F_c is higher Than The Signal.

[at 5%]

$$0.05 = \frac{50HZ / F_c}{\sqrt{1 + \left(\frac{50}{F_c}\right)^2}} = 998 \text{ HZ}$$

[effect on The Signal 70%]

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$R = \frac{9 - 2.1}{10mA} = 690\ \Omega$ [Green = 2.1v]

$R \simeq 680\ \Omega \rightarrow$ اقيم تجاري [use 10mA] ✓

10.14 mA التيار يكبر شوي max 20mA

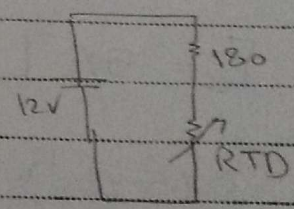
Q1 (18) $\boxed{\text{Exam!!}}$ 6/2/2020

B

Temp = (−15°C ~ 180°C)

Sensor o/P Range = [200 + (−15 × 0.39)] ~ [200 + (180 × 0.39)]

= 194.15 Ω ~ 270.2 Ω



$V_{o\,min} = 12 \times \frac{194.15}{194.15 + 180} = 6.22691\ V$

$V_{o\,max} = 12 \times \frac{270.2}{270.2 + 180} = 7.20218\ v$

Voltage Devider o/p (6.22691 ~ 7.20218)

Scale factor = 5KHZ/1.2 v ⟹ 4.1667 KHZ/V

VFC output Range (6.2269 v * 4.1667 KHZ/V

~ 7.20218 v * 41667 KHZ/V)

$(25.945458\ KHZ \sim 30.008875\ KHZ)$

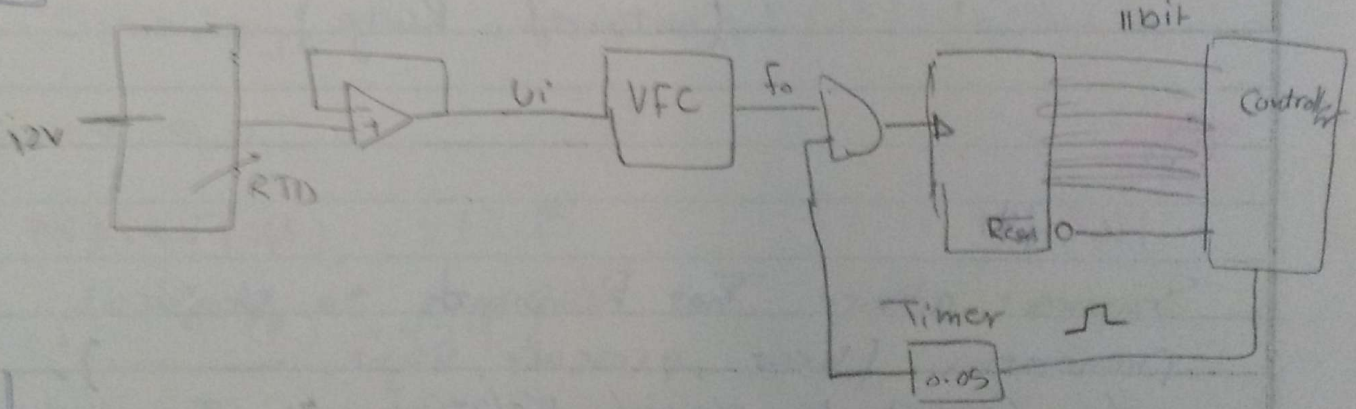
20 Sample / Sec $\rightarrow$ duty Cycle $= \frac{1}{20} = 0.05$ Sec

- Counter o/p Range: $\rightarrow$ [redacted]

$(0.05 \times 25.9454\ KHZ \sim 0.05 \times 30.00875\ kHz)$

$(1297.2729$ pulses $\sim$ 1500.44375 puls$)$

$\boxed{A}$



$\boxed{C}$

@ 112°c

Sensor o/p: $(112°c \times 2.39\ \Omega/°c) + 200 = 243.68\ \Omega$

$$VD\ o/p = 12 \times \frac{243.68}{243.68 + 180} = 6.9018\ V$$

VFC o/P $= 6.9018 \times 4.16667 = 28.7575\ KHZ$

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Counter o/p = 28.757 KHZ X 0.05 sec

= 1437.877 = $(1437)_{10}$

($(1011\,00\,1110)_2$

d) $(11111\,0\,1000)_2 \rightarrow (1000)_{10}$

which is less than The min Range (out of Range)

Q2

lect (49)

10/2/2020

Sensors: a device That Responds to physical phenomena (heat, pressure, light, ———). and Convert to signal Relating to The quantity being measured.

Sensors

contineous

LM35 ~~10 mV / c°~~

0 °C → 0 V

32 c° → 320 mV

discrete

العلامة [illegible]

(ON / Off)

1* **passive Sensor:** R, L اللي لازم احتاج تغذية زي

2* **active sensor:** solar sell زي يولد تغذية
Thermo couple

* **Sensor Selection:**

o/p
1- Range, 2- cost, 3- permability, 4- Rebliability
5- linearity, 6- Response time, 7- sensitivity
8- power consumption, 9- size, 10- Temp Range
11- Stability, 12- avilability, 13- life Time

* **Convert eq:**

$$T(C^\circ) = T(K) - 273.15$$

$$T(F^\circ) = T(R) - 459.6$$

$$T(F^\circ) = \frac{9}{5}\,T(C^\circ) + 32$$

	Rankine	Fahrenhiet	Celsius	Kelvin
	R°	F°	C°	K°
درجة غليان ←	672	212	100	373
درجة تجمد ←	492	32	0	273

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Temprature:

* PTC T↑ O/P ↑ Positive Temp Coffe

NTC T↓ O/P ↓ Negative " "

PT 1000 → Sensitive 3.9 C°/Ω

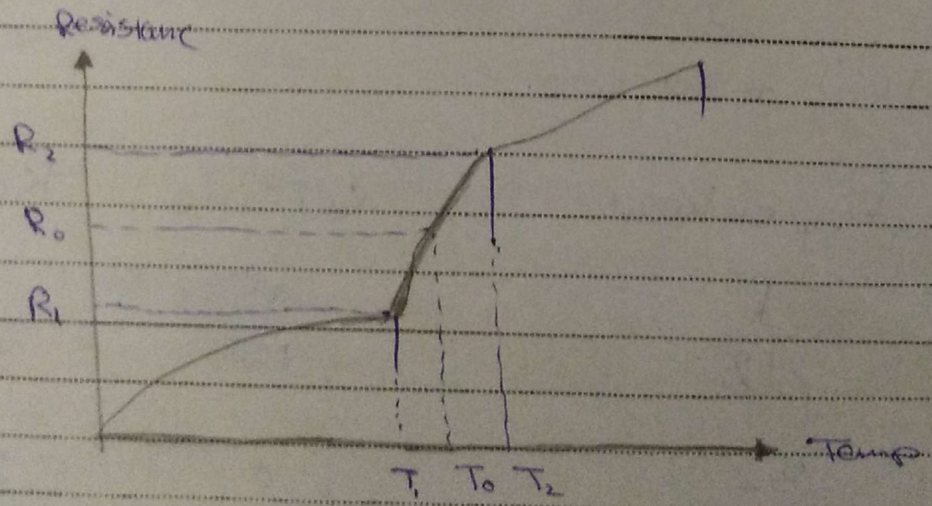
(0.5 ~ 5)s ↔ RTD زمن الاستجابة

(-100 ~ 135) بلاتين

(_180 ~ 300°C) نيكل مدى Range

* if my Sensor not linear : Two method

1%



linear approximation method

$$R(T) = R(T_0)(1 + \alpha_0 \Delta T)$$

$$\Delta T = T - T_0$$

$$\alpha_0 = \frac{1}{R(T_0)} \frac{R_2 - R_1}{T_2 - T_1}$$

$R(T)$ approximation of Resistance at Temp T

$R(T_0)$ " " " T_0

α_0 = fractional change in Resistance per degree of Temp.

lect(20) 13/2/2020

Ex: a Sample of metal Resistance versu Temperature has The following measured values.

	T(F°)	R(Ω)	
T_1	60	106.0	R_1
	65	107.6	
	70	109.1	
T_0	75	110.2	R_0
	80	111.1	
	85	111.7	
T_2	90	112.2	R_2

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Find The linear approximation of The Resistance Versus Temprature between 0 & 90°F.

$$\alpha_0 = \frac{1}{R(T_0)}\left(\frac{R_2 - R_1}{T_2 - T_1}\right)$$

$$\alpha_0 = \frac{1}{110.2}\left(\frac{112.2 - 106.0}{90 - 60}\right) = 1.8753 \times 10^{-3}$$

$T = 61°F$

$$R(T) = R(T_0)\,[1 + \alpha_0 \Delta T]$$

$$= 110.2\,[1 + 1.8753\times10^{-3}\,(61 - 75)]$$

$$= 107.3068\ \Omega$$

$T = 65°F$

$$R(T) = 110.2\,[1 + 1.8753\times10^{-3}\,(65 - 75)]$$

$$= 108.1334\ \Omega \rightarrow$$ مفروض تطلع 107.6

$T = 87°F$

$$R(T) = 112.67\ \Omega$$

نسبة الخطأ عند 60°F $= \dfrac{107.1 - 106}{107.1} = 1\%$ نسبة الخطأ !!

quadratic approximation method :

$$R(T) = R(T_0)\left[1+\alpha_1 \Delta T + \alpha_2 (\Delta T)^2\right]$$

$$\Delta T = T - T_0$$

$$\alpha_1 = \frac{1}{R(T_0)}\left(\frac{R_2 - R_1}{T_2 - T_1}\right)$$

Same as pervious Ex using quadratic :

$$R(T) = R(T_0)\left[1+\alpha_1 \Delta T + \alpha_2 (\Delta T)^2\right]$$

$$112.2 = 110.2\left[1+\alpha_1 (90-75) + \alpha_2 (90-75)^2\right]$$

$$106.0 = 110.2\left[1+\alpha_1 (60-75) + \alpha_2 (60-75)^2\right]$$

0.01814

$$0.018 = \left[\alpha_1 15 + 225\,\alpha_2\right]$$

-0.03811

$$-0.038 = \left[\alpha_1 15 + 225\,\alpha_2\right]$$

1.875×10^{-3} $\quad$ -44.37×10^{-6}

$$\alpha_1 = 1.8667\times10^{-3},\quad \alpha_2 = -4.444\times10^{-5}$$

$T = 61 f^\circ$

106.348 Ω

$R(T) = 106.36\ \Omega$

$T = 65 f^\circ$ $\quad$ 107.644 Ω

$R(T) = 107.65\ \Omega$

$T = 87\ F^\circ$

111.777 Ω

$R(T) = 111.96\ \Omega$

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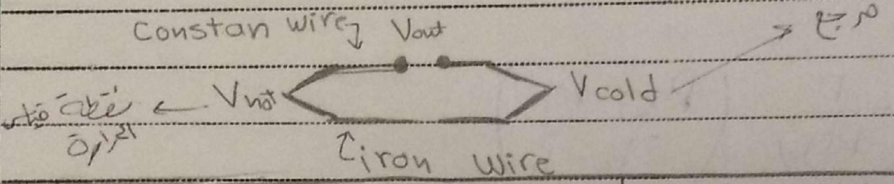
Thermo Couple:
(المزدوج الحراري)



"لازم نستخدم جدول"

Junction material	Range (c°)	nominal sensitivity (Mv/C°)	Type
* Platinum 6% / Rhodium Platinum 30% / Rhodium	38 ~ 1800	7.7	B
Tungesten 5% / Rhenium — " 26% / "	0 ~ 2300	16	C
chromel - Constan	0 ~ 982	76	E
iron - Constan	0 ~ 760	55	J
chromel - Alumel	184 ~ 126	39	K

1* Controlled Temperture reference block.

2 Reference Composition Circuit

3 Software Reference Correction.

Composition طرق ال *

* خرج المحسس ب MV

0 5 10 15 20 ....

-0 → الفولتيات بدو بالسالب

+0 → " " بالموجب

* عند درجة 0°C

J- Type

25°C = 1.28 mV

-30°C = -1.48 mV

675°C = 37.6 mV

-95°C = -4.42 mV

-125°C = -5.61 mV

-55°C = -2.66 mV

$$T_m = T_L + \left[\frac{T_H - T_L}{V_H - V_L}\right](V_m - V_L)$$

$$V_m = V_L + \left[\frac{V_H - V_L}{T_H - T_L}\right](T_M - T_L)$$

لما يكون الرقم مش موجود في الجدول interpolation

EX: a Voltage of 23.72 mV is measured with K Thermo Couple, find The Temperture of measurment Junction :

$\left.\begin{array}{l} V_L = 23.63 \\ T_L = 570°C \end{array}\right\}$ أصغر من V_m T_m

$\left.\begin{array}{l} V_H = 23.84 \\ T_H = 575°C \end{array}\right]$ أكبر من V_m T_m

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$T_m = 572.1429\,°c$ using equation

EX: Find The Voltage of Type J Thermocouple with Zero degree refrence if Shunt Temp is $-172°c$

$V_m = -7.18\ mV$.

$T_m = -172°c$

$V_H = -7.12\ mv$

$V_L = -7.27\ mv$

$T_H = -170°c$

$T_L = -175°c$

24/2/2020 lect(22) 463

Change of Table Reference:

EX: a Type J ThermoCouple with 25°c reference is used to measure over Temp from 300°c to 400°c, what outputs Voltage Corresponed to These Temp?

$$V_{J_x}(T) = V_{J_0}(T) - V_{J_0}(X) \rightarrow (1)$$

ref = 15°c
T = 45°c

ref = 0°c
T = 45
[illegible] = 2.32 mV

① $V_{J15}(45) = V_{J_0}(45) - V_{J_0}(15)$

x = new ref
T = Temp

$= 2.32 - 0.76$

$= 1.56$

$$\cancel{V_{J25}(T) = V_{J_0}(T) - V_{J_0}(X)}$$

$$V_{J25}(300) = V_{J_0}(300) - V_{J_0}(25)$$

$$= 16.33 - 1.28$$

$$V_{J25}(300) = 15.05 \text{ mV}$$

using (1)

$$V_{J25}(400) = V_{J_0}(400) - V_{J_0}(25)$$

$$= 21.85 - 1.28$$

$$V_{J25}(400) = 20.57 \text{ mV}$$

EX: a Type K Thermo couple with 75f reference produce a Voltage of 35.56 mV when is the Temp?

$$T(c) = \frac{5}{9}(75 - 32) = 23.89°c$$

$T_h = 25$ $V_H = 1$

$T_L = 20$ $V_L = 0.8$

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$$T_m = T_L + \left[\frac{T_H - T_L}{V_H - V_L}\right](V_m - V_L)$$

$$V_m = V_L + \left[\frac{V_H - V_L}{T_H - T_L}\right](T_m - T_L)$$

$$V_m = 0.8 + \left[\frac{1 - 0.8}{25 - 20}\right](23.89 - 20)$$

$$V_m = 0.9556 \text{ mV}$$

$$V_{23.89}(T) = V(\cancel{\ }) - V(23.89)$$

$$35.56\text{mv} = V_{J_0}(T) - 0.9556$$

$$V_{J_0}(T) = 36.5156$$

$$T_m = 875 + \left[\frac{880 - 875}{36.55 - 36.35}\right](36.5156 - 36.35)$$

$$T = 879.14°c$$

lect(23)

2/3/2020

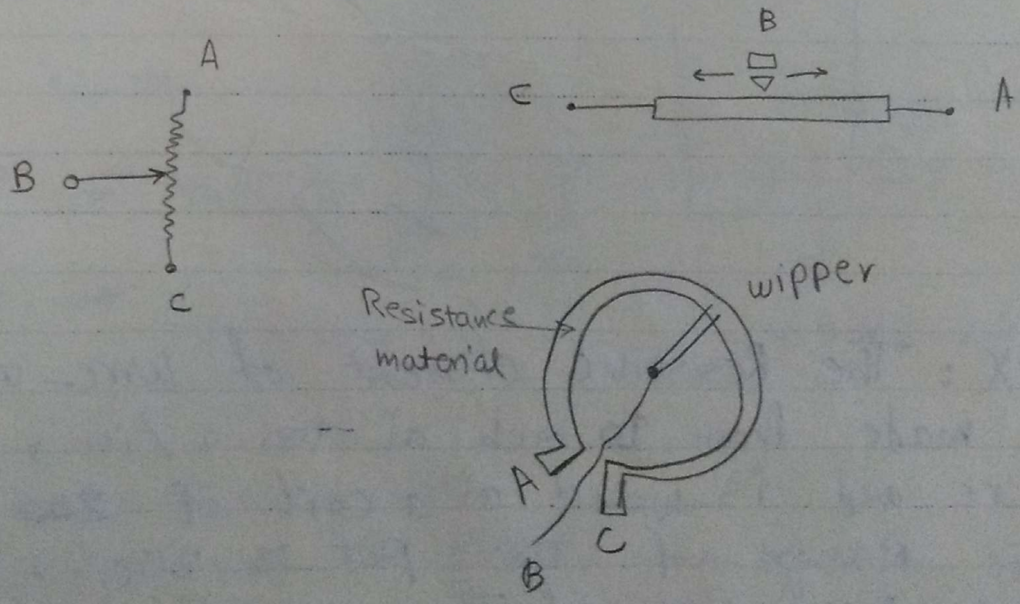
Displacement (position Sensor):

- position Sensor Report The physical position of an object with Respect to a Reference point.

- The information Can be an angle as in how many degrees, or linear as how many inches.

Potentiometer:

- a potentiometer Can be used to Convert rotary or linear displacement to a Voltage, actually The pot itself gives Resistance, but The Resistance Value Can easily be Converted to a Voltage.



AgiP آجيب	INTERNAL NOTES	Date	N
FROM	TO	Your Ref / Our Ref	
Subject	degree not Temp		

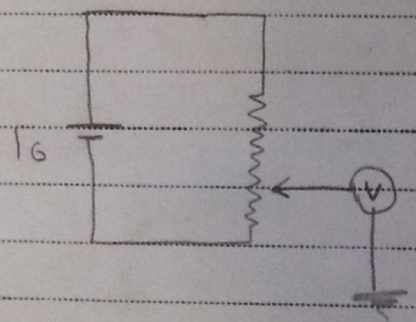
EX: a pot is Supplied with 10 v & is set at 82°, The Range of This pot is 350° calculate The output Voltage ?

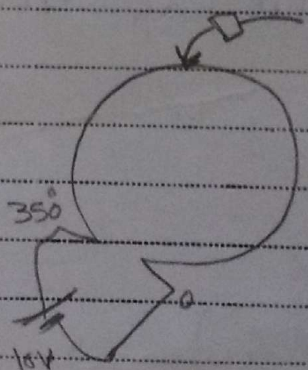
10V ⟶ 350°

0V ⟶ 0°

$\frac{10V}{350°C} = 0.0285 \frac{V}{C°}$ ⟶ Sensitivity

o/p Voltage at 82° = $82° \times 0.0285 \frac{V}{C°} = 2.34V$





EX: The Resistive element of Wire-wound pot is made from 10 inch of 100 Ω/in, Resistance wire and is wond as a coil of 200 loops The Range of The pot is 350°, what is The Resolution of This pot ?

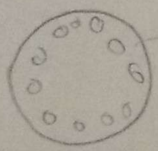
Resolution → آقل قيمة نقدر نقيسها

- Pot $R_{total} = 10\text{ inch} \times 100 \frac{\Omega}{\text{inch}} = 1000\ \Omega$

- $\frac{1000\ \Omega}{200\text{ loop}} = \frac{5\ \Omega}{\text{loop}}$.

- $\frac{350^\circ}{200\text{ loop}} = 1.75 \frac{^\circ}{\text{loop}}$ → Resolution آقل زاوية نقدر نقيسها

Rotary Encoder :

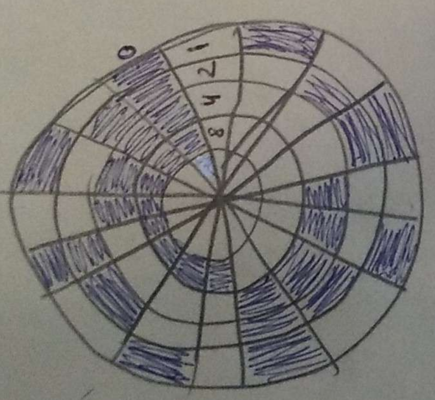


كل ~~pulse~~ تكة بمسافة تتحسب

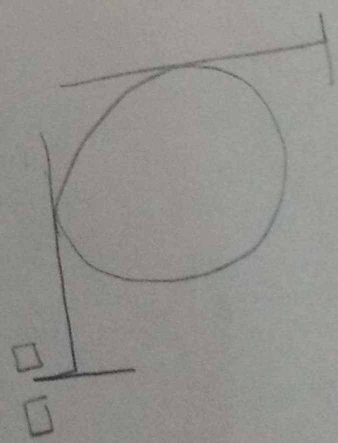
~~[illegible]~~

الـ mouse دويرة

~~[illegible]~~



incremental incoder



absolute Incoder

*الدائرة الداخلية لا تحسب.

0110

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